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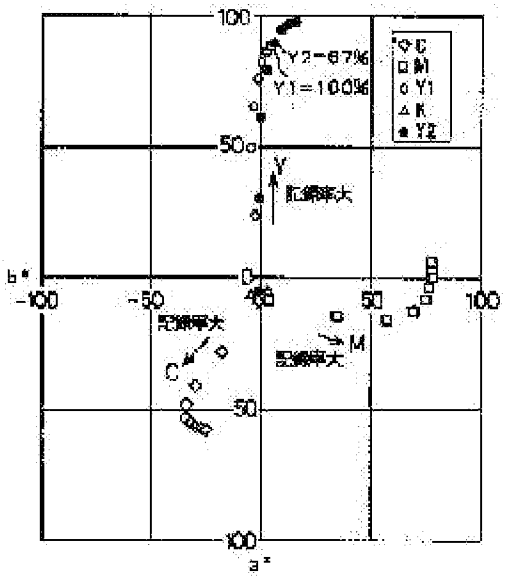
(54) PRINTER, PRINTING METHOD, AND INK CARTRIDGE THEREFOR



(57)Abstract:

PROBLEM TO BE SOLVED: To suppress generation of granular feeling while reducing the delivery of three kinds or more of ink which can represent a hue in a predetermined range through mixing.

SOLUTION: Recording rate is determined for each color ink from an input gradation data of each color with reference to tables TC, TM and TY and a dot is formed depending on the recording rate. Since the dye density of yellow ink is set higher than a color balanced density, recording rate of yellow Y becomes lower than the recording rate of cyan C and magenta M. Yellow Y has high lightness and the granular feeling is not conspicuous even if the dots are formed sparsely for a region of low gradation data. Since the density of yellow ink Y is increased, the quantity of ink to be jetted from a head is decreased for a required density.

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CLAIMS

[Claim(s)]
[Claim 1]It is the printer provided with a head recordable on printed matter for three or more kinds of ink which can express hue of a prescribed range by being intermingled, The ratio of concentration of ink with the highest brightness per same recording rate among said each color ink, and other ink, A printer which has a compensation means which amends recording quantity of ink with this highest brightness to a ratio which is provided with this each color ink so that color balance when a recording rate per unit area of these ink is made equal may incline toward the ink side with this highest brightness, and corrects this bias.
[Claim 2]It is the printer provided with a head recordable on printed matter for three or more kinds of ink which can express hue of a prescribed range by being intermingled, The ratio of concentration of ink with the lowest visibility of granulation at the time of considering it as the same recording rate among said each color ink, and other ink, A printer which has a compensation means which amends recording quantity of ink with the lowest visibility of this granulation to a ratio which is provided with this each color ink so that it may incline toward the ink side with the lowest visibility of this granulation of color balance when a recording rate per unit area of these ink is made equal, and corrects this bias.
[Claim 3]The printer according to claim 1 or 2 ink with said highest brightness or whose ink with the lowest visibility of granulation said three or more kinds of ink is Hierro, magenta, and cyanogen, and is Hierro.
[Claim 4]The printer according to claim 1 or 2 made higher in the 1.1 thru/or 4 times as many ranges than in concentration with which it balances when dye concentration of ink with said highest brightness or ink with the lowest visibility of granulation has an equal recording rate per unit area of three or more kinds of said ink.
[Claim 5]The printer according to claim 1 or 2 which is what reduces a rate of formation of a dot according [amendment of recording quantity of ink with said highest brightness or ink with the lowest visibility of granulation] to this ink.
[Claim 6]The printer according to claim 1 or 2 which is what reduces a path of a dot according [amendment of recording quantity of ink with said highest brightness or ink with the lowest visibility of granulation] to this ink.
[Claim 7]Said three or more kinds of each ink which is the printer according to claim 1 or 2, and is recorded on said printed matter, A printer which a color or paints are provided by solvent as melting or a dispersed solution, and said head is a head which carries out the regurgitation of the solution containing this color or paints to this printed matter, and is a means by which said compensation means amends discharge quantity of ink.
[Claim 8]About ink other than ink in which it is the printer according to claim 7, and amendment

of discharge quantity is made among three or more kinds of ink provided as said solution. Having ink of concentration of two or more kinds of shades, said head is a printer in which regurgitation is possible in ink of concentration of two or more kinds of these shades about ink with said said highest brightness, or ink with the lowest visibility of granulation.
[Claim 9]The printer according to claim 8 whose dye concentration of low concentration ink of each color it has said shading ink about each color ink of magenta and cyanogen, and is abbreviated 1 / 4 of dye concentration of high concentration ink.
[Claim 10]The printer according to claim 7 provided with a mechanism in which said head carries out the regurgitation of the ink particles with a pressure given to ink by impression of voltage to an electrostriction element provided in an ink passage.
[Claim 11]The printer according to claim 7 provided with a mechanism which carries out the regurgitation of the ink particles with a pressure given to ink of this ink passage with air bubbles which generate said head by energization to a heating element provided in an ink passage.
[Claim 12]The printer according to claim 1 or 2 provided with a means to determine existence of a dot by said each color ink with a dither method.
[Claim 13]The printer according to claim 12 which is a threshold matrix of distributed type [threshold matrix / of said dither method].
[Claim 14]It has a head which can record three or more kinds of ink which can express hue of a prescribed range by being intermingled, It is the method of controlling distribution of a dot of this ink beyond 3 kind based on a gradation signal of a picture which it is going to print, and printing a picture of multi-tone, The ratio of concentration of ink with the highest brightness per same recording rate among said each color ink, and other ink, A printing method which amends recording quantity of ink with this highest brightness to a ratio which sets up so that color balance when a recording rate per unit area of these ink is made equal may incline toward the ink side with this highest brightness, and corrects this bias.
[Claim 15]It has a head which can record three or more kinds of ink which can express hue of a prescribed range by being intermingled, It is the method of controlling distribution of a dot of this ink beyond 3 kind based on a gradation signal of a picture which it is going to print, and printing a picture of multi-tone, The ratio of concentration of ink with the lowest visibility of granulation at the time of considering it as the same recording rate among said each color ink, and other ink, A printing method which amends recording quantity of ink with the lowest visibility of this granulation to a ratio which sets up incline toward the ink side with the lowest visibility of this granulation of color balance when a recording rate per unit area of these ink is made equal, and corrects this bias.
[Claim 16]It is an ink cartridge equipped with and used for the printer according to claim 1 or 2, Three or more kinds of ink which can express hue of a prescribed range is stored by being intermingled, About ink with said highest brightness among this ink beyond 3 kind, or ink with the lowest visibility of granulation. An ink cartridge which the dye concentration was set up compared with other ink more highly than concentration which balances when a recording rate per unit area is equal, and made the capacity capacity equivalent to capacity of other ink, or small.
[Claim 17]An ink cartridge which made capacity of ink which is equipped with and used for the printer according to claim 8, and in which are an ink cartridge and said brightness is the highest, or ink with the lowest visibility of granulation many [equivalent to each capacity of ink which was prepared as for said two or more kinds of shades, or] capacity.
[Claim 18]It is an ink cartridge used for the printing method according to claim 14 or 15, Three or more kinds of ink which can express hue of a prescribed range is stored by being intermingled, About ink with said highest brightness among this ink beyond 3 kind, or ink with

the lowest visibility of granulation. An ink cartridge which the dye concentration was set up compared with other ink more highly than concentration which balances when a recording rate per unit area is equal, and made the capacity capacity equivalent to capacity of other ink, or small.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]It is intermingled in this invention.
Therefore, it has a head which can record three or more kinds of ink which can express the hue of a prescribed range, and is related with the ink cartridge used for the printer, the printing method, and this which can record the picture of multi-tone in the ink recorded on printed matter by this head.

[0002]
[Description of the Prior Art]In recent years, as an output unit of a computer, the color printer of the type which records the ink of several colors on printed matter by a head spreads widely, and it is widely used for printing the picture which the computer etc. processed with multicolor multi-tone. The hot printing method which fuses the ink on an ink ribbon and is transferred in a paper as a method of recording ink on printed matter, Various techniques, such as an inkjet method which turns the solution of color ink to a paper and carries out the regurgitation, and an electrophotographying system which forms a latent image on a photo conductor with laser, and transfers color toner, are known. In reproducing the color of the range of predetermined hue in any case and carrying out full color printing to it by intermingling the ink of several kinds of colors, it usually uses the ink of three colors of cyanogen, magenta, and yellow (CMY).
[0003]Some methods can be considered for it to form the picture of multi-tone when printing a multicolor picture in two or more kinds of such ink. One is a technique adopted with the conventional printer.
The density (frequency of occurrence per unit area) of a dot expresses the gradation of the picture printed, seting as constant the size of the dot formed on a paper in the ink which carries out the regurgitation at once.
Another method adjusts the dot diameter formed on a paper, and changes the concentration per unit area. These days, micro processing of the head which forms ink particles progresses, and density of a dot, a variable range of a dot diameter, etc. which can be formed per predetermined length are improving every year.
[0004]
[Problem(s) to be Solved by the Invention]However, in the case of a printer, it has stopped at tens of microns with 300dpi thru/or about 720 dpi, and particle diameter at print density (resolution), and the distance between the power of expression (on a film, called thousands dpi in resolution) of a film photo is still large. In particular, a dot will be formed sparsely (what is called granulation), and this will stand out in the field where image concentration is low, i.e., the field where the dot density printed is low. In the printer of the type which carries out the regurgitation of the liquefied ink to a paper, the total amount of the ink breathed out per unit area is restricted by possible ink absorption (what is called an ink duty) on a paper. In the printer which uses two or more kinds of ink for color printing, it was also a technical problem to clear this restriction in the low paper of an ink duty. Especially the problem of this ink duty prepares

the ink of two kinds of shades about each color ink, and in the low field of gradation, when it prints using ink with low concentration and is going to make granulation not conspicuous, it actualizes it. It is because the total amount of the ink which carries out the regurgitation will increase if it is going to express predetermined gradation using light ink.
[0005]In the printer provided with the head in which the regurgitation is possible for three or more kinds of ink which can express the hue of a prescribed range by being intermingled, an object [without adjusting the concentration of specific ink and falling the grace of the picture recorded] of this invention is to ease restriction of an ink duty etc.
[0006]
[The means for solving a technical problem, and its operation and effect] The following composition was used for the invention in this application in order to attain this purpose. First, in the printer provided with the head recordable on printed matter for three or more kinds of ink which can express the hue of a prescribed range when the 1st printer of this invention was intermingled, The ratio of concentration of the ink with the highest brightness per same recording rate among said each color ink, and other ink, It has this each color ink so that color balance when the recording rate per unit area of these ink is made equal may incline toward the ink side with this highest brightness, and it is making into the gist to have a compensation means which amends the recording quantity of the ink with this highest brightness to the ratio which corrects this bias.
[0007]The 1st printing method of this invention is provided with a head recordable on printed matter for three or more kinds of ink which can express the hue of a prescribed range by being intermingled, It is the method of controlling distribution of the dot of this ink beyond 3 kind based on the gradation signal of the picture which it is going to print, and printing the picture of multi-tone, The ratio of concentration of the ink with the highest brightness per same recording rate among said each color ink, and other ink, It sets up so that color balance when the recording rate per unit area of these ink is made equal may incline toward the ink side with this highest brightness, and it is making into the gist to amend the recording quantity of the ink with this highest brightness to the ratio which corrects this bias.
[0008]By being intermingled, this printer and printing method are provided with a head which can record three or more kinds of ink which can express hue of a prescribed range, and form various hue and a picture of brightness (concentration) by forming a dot in these ink at a predetermined rate. He loses purposely color balance when a recording rate per unit area of each color ink is made equal, and is trying for color balance to incline toward the ink side with the highest brightness per same recording rate with a printer of this invention in that case. Therefore, if a recording rate per unit area is made the same, since color balance inclines toward the ink side with the highest brightness, it will amend recording quantity of ink with the highest brightness to a ratio which corrects this bias by a compensation means. As a result, a total amount of all the ink recorded can be reduced, without spoiling quality of a picture formed, since recording quantity of ink which color balance becomes normal, and its brightness is the highest, and has little influence of granulation by low concentration is reduced.
[0009]In a printer provided with a head recordable on printed matter for three or more kinds of ink which can express hue of a prescribed range when the 2nd printer of this invention was intermingled, The ratio of concentration of ink with the lowest visibility of granulation at the time of considering it as the same recording rate among said each color ink, and other ink, It has this each color ink so that it may incline toward the ink side with the lowest visibility of this granulation of color balance when a recording rate per unit area of these ink is made equal, and it is making into a gist to have a compensation means which amends recording quantity of ink with the lowest visibility of this granulation to a ratio which corrects this bias.

[0010]The 2nd printing method of this invention is provided with a head recordable on printed matter for three or more kinds of ink which can express hue of a prescribed range by being intermingled, It is the method of controlling distribution of a dot of this ink beyond 3 kind based on a gradation signal of a picture which it is going to print, and printing a picture of multi-tone, The ratio of concentration of ink with the lowest visibility of granulation at the time of considering it as the same recording rate among said each color ink, and other ink, It sets up incline toward the ink side with the lowest visibility of this granulation of color balance when a recording rate per unit area of these ink is made equal, and is making into a gist to amend recording quantity of ink with the lowest visibility of this granulation to a ratio which corrects this bias.
[0011]In this printer and printing method, like the 1st printer and the 1st printing method, By being intermingled, it has a head which can record three or more kinds of ink which can express hue of a prescribed range, and various hue and a picture of brightness (concentration) are formed by forming a dot in these ink at a predetermined rate. He loses purposely color balance when a recording rate per unit area of each color ink is made equal, and is trying for color balance to incline toward the ink side with the lowest visibility of granulation at the time of considering it as the same recording rate with a printer of the 2nd invention in that case. Therefore, if a recording rate per unit area is made the same, since color balance inclines toward the ink side with the lowest visibility of granulation, it will amend recording quantity of ink with the lowest visibility of granulation to a ratio which corrects this bias by a compensation means. As a result, a total amount of all the ink recorded can be reduced, without spoiling quality of a picture formed, since color balance becomes normal and recording quantity of ink with the low visibility of granulation is reduced.
[0012]It is practical to choose Hierro as ink with the highest brightness or ink with the lowest visibility of granulation practical [adopting ink of Hierro as what is called the three primary colors, magenta, and cyanogen] as three or more kinds of ink in such a printer. What is necessary is from the first, just to choose ink with the highest brightness, or ink with the lowest visibility of granulation in those colors in the case of combination of other colors.
[0013]Although the technique toward which color balance of combination of each color ink is biased can consider various approaches, It is making dye concentration of the ink with the highest brightness as one, or ink with the lowest visibility of granulation higher in the 1.1 thru/or 4 times as many ranges than concentration which balances when a recording rate per unit area of three or more kinds of ink is equal. Granulation will be sensed, if an effect by concentration having raised concentration in less than 1.1 times cannot be expected but it is made higher than 4 times. Since adjustment of dye concentration is easy, it can be easily made into a bias of a request of color balance.
[0014]In this case, amendment of recording quantity of ink with the highest brightness or ink with the lowest visibility of granulation can be attained by reducing a rate of formation of a dot in this ink. It is possible to reduce a path of a dot in this ink as the technique of other amendments.
[0015]Making beforehand larger than a dot diameter of other ink a dot diameter of ink with the highest brightness as one of the techniques toward which color balance of combination of each color ink is biased beforehand, or ink with the lowest visibility of granulation is also considered. A compensation means in this case can be amended by reducing a rate of dot formation.
[0016]As a method recorded on printed matter, three or more kinds of ink, Can apply an all directions type known from the former, and for example, three or more kinds of each ink, A solution which shall provide a solvent with a color or paints as melting or a dispersed solution, and contains these color or paints for a head can be used as a head which carries out the

regurgitation to this printed matter, and a compensation means can be made into a means which amends discharge quantity of ink. The technique of carrying out the regurgitation of the solution form ink can form a detailed dot at comparatively high speed, and is preferred.
[0017]In a printer using such solution form ink, about ink other than ink in which amendment of discharge quantity is made among three or more kinds of ink. It shall have ink of concentration of two or more kinds of shades, and said head can also be made possible for regurgitation of ink with said said highest brightness, or ink with the lowest visibility of granulation with ink of concentration of two or more kinds of these shades. That is, about ink whose visibility of granulation is to some extent high, light ink with low concentration is prepared and granulation of a field where concentration is low is prevented.
[0018]When combination of a color is Hierro, magenta, and cyanogen as this shading ink, It is also preferred from points, such as nature of a concentration change of a mixture part of shading ink, to have ink of two or more kinds of shades about magenta and cyanogen, and to set dye concentration of low concentration ink of each color to abbreviated 1 / 4 of dye concentration of high concentration ink.
[0019]The technique of formation of a dot of each color shall determine existence of a dot by said each color ink, for example with a dither method, although various techniques are permitted. When adopting such a dither method, a threshold matrix which defines turning on and off of a dot can be made into a distributed type threshold matrix. If a distributed type threshold matrix is used, it is advantageous from a point of dot formation in which dot distribution is distributed and it is hard to impress granulation.
[0020]A mechanism of dot formation in such a printer shall equip a head with a mechanism which carries out the regurgitation of the ink particles with a pressure given to ink by impression of voltage to an electrostriction element provided in an ink passage, for example, although various things are known. Or composition provided with a mechanism which carries out the regurgitation of the ink particles with a pressure given to ink of this ink passage with air bubbles by which it is generated by energization to a heating element provided in an ink passage can also be taken.
[0021]What equips with an ink cartridge of this invention a printer mentioned above, and is used, Or it is used for a printing method mentioned above, and three or more kinds of ink which can express hue of a prescribed range is stored by being intermingled, About ink with said highest brightness among this ink beyond 3 kind, or ink with the lowest visibility of granulation. The dye concentration is set up compared with other ink more highly than concentration which balances when a recording rate per unit area is equal, and it is making to have made the capacity into capacity equivalent to capacity of other ink, or small into a gist.
[0022]In a printer and a printing method which were mentioned above, concentration of ink with the highest brightness per same recording rate or ink with the lowest visibility of granulation is raised, and the volume amount used is reduced. Therefore, a period until it exhausts each color ink can be made comparable by making capacity of ink with the highest brightness per same recording rate, or ink with the lowest visibility of granulation into capacity equivalent to other ink, or small.
[0023]In two or more kinds of shades preparing ink other than ink with the highest brightness, or ink with the lowest visibility of granulation, Since the amount of shade each ink used itself decreases, an ink cartridge which made capacity of ink with the highest brightness or ink with the lowest visibility of granulation larger than ink capacity of shade each of these colors is also useful.
[0024]
[Other modes of an invention] This invention contains other following modes. The 1st mode is

composition which puts some means of a printer on the device side which outputs not an inside of a case but a picture which it is going to print of a printer. It is realizable by a discrete circuit, and a compensation means is realizable also with software in an arithmetic logic operation circuit centering on CPU. To processing about generation of a dot, make it carry out to a side which outputs a picture which it is going to print in the case of the latter, for example, a computer, and in a case of a printer, A gestalt which stores only a mechanism which controls regurgitation of ink from a head and forms a generated dot on a paper etc. can also be considered.
[0025]The 2nd mode of this invention is a gestalt as a portable storage medium which recorded software which is loaded to a computer system and performed, An arithmetic logic operation circuit (hardware) centering on CPU and a software program executed on it shall realize at least a part of means to perform processings, such as the above-mentioned compensation means. At least a part of that software program is stored in this portable storage medium.
[0026]The 3rd gestalt is a gestalt as a feed unit which supplies the above-mentioned software program via a communication line.
[0027]There is an invention of an ink cartridge used for a printer mentioned above as the 4th gestalt. For example, when a printer of this invention color-prints using two or more color ink, an ink cartridge which stores three or more kinds of color ink in a container of a different body with black ink can be considered. black ink used for printing of a stage of that exchange centering on the usual character since this ink cartridge is stored by container different from black ink -- it is not influenced at skilled exhaustion and its exchange time.
[0028]
[Embodiment of the Invention]Next, an embodiment of the invention is described based on an example. Drawing 1 is an outline lineblock diagram of the printer 20 which is one example of this invention. The mechanism in which this printer 20 conveys the paper P with the paper feed motor 22 so that it may illustrate, The mechanism in which the carriage 30 is made to reciprocate to the shaft orientations of the platen 26 with the carriage motor 24, It comprises the control circuit 40 which manages an exchange of the signal of the mechanism which drives the printhead 28 carried in the carriage 30, and controls the regurgitation and dot formation of ink, and these paper feed motors 22, the carriage motor 24, the printhead 28 and the navigational panel 32.
[0029]The mechanism in which the paper P is conveyed is provided with the gear train which transmits rotation of the paper feed motor 22 not only to the platen 26 but to the paper conveyance roller which is not illustrated (graphic display abbreviation). The mechanism in which the carriage 30 is made to reciprocate, It comprises position detection sensor 39 grade which detects the sliding shaft 34 which is constructed in parallel with the axis of the platen 26, and holds the carriage 30 so that sliding is possible, the belt pulley 38 which stretches the endless driving belt 36 between the carriage motors 24, and the home position of the carriage 30.
[0030]Drawing 2 showed the composition of this printer 20 centering on the control circuit 40. illustrating -- as -- this -- a control circuit -- 40 -- common knowledge -- CPU -- 41 -- a program -- etc. -- having memorized -- P-ROM -- 43 -- RAM -- 44 -- a character -- a dot matrix -- having memorized -- a character generator -- (-- CG --) -- 45 -- etc. -- a center -- carrying out -- arithmetic logic operation -- a circuit -- ****** -- constituting -- having -- **** -- in addition. It has the I/F dedicated communication circuit 50 which performs an interface with an external motor etc. for exclusive use, the head drive circuit 52 which is connected to this I/F dedicated communication circuit 50, and drives the head 28, and the motor drive circuit 54 which similarly drives the paper feed motor 22 and the carriage motor 24. The parallel interface circuit is built in, it is connected to a computer via the connector 56, and the I/F dedicated communication circuit 50 can receive the signal for printing which a computer outputs. The output of the picture signal from a computer is mentioned later.

[0031]Next, the regurgitation principle of the ink by the concrete composition of the carriage 30 and the printhead 28 carried in the carriage 30 is explained. Drawing 3 is a perspective view showing the shape of the carriage 30. Drawing 4 is a top view showing the nozzle part which carries out the regurgitation of each color ink in the printhead 28 arranged by the lower part of the carriage 30. As shown in drawing 3, the carriage 30 is carrying out the shape of approximately L type, and is provided with the divider plate 31 into which loading of the cartridge for black ink and the cartridge 70 (refer to drawing 5) for color ink which are not illustrated is possible, and both cartridges are divided so that wearing is possible. A total of six heads 61 thru/or 66 for ink discharge are formed in the printhead 28 of the lower part of the carriage 30, and the introducing pipes 71 thru/or 76 which lead the ink from an ink tank to each of this head for colors are set up by the pars basilaris ossis occipitalis of the carriage 30. If the carriage 30 is equipped with the cartridge and the cartridge 70 for color ink for black ink from the upper part, the introducing pipes 71 thru/or 76 will be inserted in the connecting hole established in each cartridge.

[0032]The mechanism in which ink is breathed out is explained briefly. If the carriage 30 is equipped with the cartridge 70 for ink as shown in drawing 6, using capillarity, the ink in the cartridge for ink will be sucked out via the introducing pipes 71 thru/or 76, and will be led to each color heads 61 thru/or 66 of the printhead 28 provided in the carriage 30 lower part. When equipped with an ink cartridge for the first time, operation which attracts ink on each color heads 61 thru/or 66 with a pump for exclusive use is performed, but in this example, a graphic display and explanation are omitted for the printhead 28 about the composition of a wrap cap etc. at the time of the pump for suction, and suction.

[0033]As shown in drawing 4 and drawing 6, in each color heads 61 thru/or 66, the 32 nozzles n are formed for every color, and piezo-electric element PE which is one of the electrostriction elements and was excellent in the response for every nozzle is arranged at them. Drawing 7 showed the structure of piezo-electric element PE and the nozzle n in detail. Piezo-electric element PE is installed in the position which touches the ink passage 80 to which ink is led to the nozzle n so that it may illustrate. Piezo-electric element PE is an element which a crystal structure is distorted by impression of voltage and changes electric-mechanical energy at very high speed as everyone knows. In this example, by impressing the voltage of specified time width to inter-electrode [which was provided in the both ends of piezo-electric element PE], as shown in the drawing 7 lower berth, piezo-electric element PE elongates only the applying time of voltage, and changes one side attachment wall of the ink passage 80. As a result, it contracts according to extension of piezo-electric element PE, the ink equivalent to a part for this contraction serves as the particles Ip, and the volume of the ink passage 80 is breathed out at high speed from the tip of the nozzle n. Printing will be performed when this ink particle Ip sinks into the paper P with which the platen 26 was equipped.

[0034]The arrangement of each color heads 61 thru/or 66 in the printhead 28 is divided and allocated in 3 sets by making two heads into a lot, as shown in drawing 4 on the relation which arranges piezo-electric element PE mentioned above. The head 61 for black ink is allocated by the end of the side close to the cartridge for black ink, and the next door is the ink head 62 for cyanogen. the ink (it is hereafter called Light cyan, Inc.) whose concentration is lower than the cyan ink in which adjoining this group is supplied to the ink head 62 for cyanogen -- they are the head 63 of business, and the ink head 64 for magentas. the ink (it is hereafter called light magenta ink) in the next group whose concentration is lower than usual magenta ink -- the head 65 of business and the head 66 for Hierro are arranged. A presentation and concentration of each ink are mentioned later.

[0035]The printer 20 of this example which has the hardware constitutions explained above,

Rotating platen 26 and other rollers with the paper feed motor 22, and conveying the paper P.The carriage 30 is made to reciprocate with the carriage motor 24, piezo-electric element PE of each color heads 61 thru/or 66 of the printhead 28 is driven simultaneously, the regurgitation of each color ink is performed, and a multicolor picture is formed on the paper P. The printer 20 forms a multicolor picture based on the signal received from image forming devices, such as the computer 90, via the connector 56, as shown in drawing 8. In this example, the application program which is operating by computer 90 inside shows the picture to CRT display 93 via the video driver 91, processing a picture. If this application program 95 publishes a printing instruction, the printer driver 96 of the computer 90 would receive picture information from the application program, and will have changed this into the signal which can print the printer 20. In the example shown in drawing 8, inside the printer driver 96, As opposed to the rasterizer 97 which changes into the sexual desire news of a dot unit the picture information which the application program 95 is treating, and the picture information (gradation data) changed into the sexual desire news of the dot unit. By the existence of the ink in a dot unit from the color correction module 98 which performs color correction according to the characteristic of coloring of an image output device (here printer 20), and the picture information after color correction was carried out. It has the half tone module 99 which generates the so-called picture information of the half-tone expressing the concentration in a certain area. Since operation of each of these modules is a well-known thing, explanation is omitted in principle and the contents of the half tone module 99 are later mentioned for it.

[0036]As explained above, the printer 20 of this example equips the printhead 28 with the head in which the regurgitation is possible for each color ink. Hierro, Inc. Y and the black ink K which are breathed out by this head make the rate of a color 2.7 mass percents and 4.8 mass percent, respectively, using direct IERO 86 and the food black 2 as a color, as that ingredient was shown in drawing 9. The heads 63 and 65 for Light cyan, Inc. and light magenta ink are formed in the printhead 28 in addition to the ink of four so-called colors of CMYK containing this Hierro and black. These light cyan ink and light magenta ink make low dye concentration of usual cyan ink and magenta ink, as shown in drawing 9.

[0037]Usually so that it may illustrate the cyan ink (shown in [C1] drawing 9) of concentration, As opposed to using 3.6 mass percents, a 30 mass percent diethylene glycol, and SAFI Norian 465 as 1 mass percent and 65.4 mass percent water for the direct blue 99 which is a color, Direct blue 99 which is light cyan ink (shown in [C2] drawing 9) and a color is made into 0.9 mass percents which are 1/4 of the cyan ink C1, for viscosity control, a diethylene glycol is changed into 35 mass percents, and water is changed into 63.1 mass percents. Usually the magenta ink (shown in [M1] drawing 9) of concentration, As opposed to using 2.8 mass percents, a 20 mass percent diethylene glycol, and SAFI Norian 465 as 1 mass percent and 79 mass percent water for the acid red 289 which is a color, Light magenta ink (shown in [M2] drawing 9) changes the acid red which is a color into 0.7 mass percents, the 25 mass percent diethylene glycol, and 74 mass percent water which are 1/4 of the magenta ink M1. As for any ink, viscosity is adjusted to about 3 [mPa-s] grade. In this example, since surface tension besides the viscosity of each color ink is adjusted identically, it does not depend on the ink which forms a dot, but control of piezo-electric element PE for every color head can be made the same.

[0038]2 and Y are stored among these ink in the color ink [except black] C1, C2, M1, and M ink cartridge 70 shown in drawing 5, and the capacity is made into what has more Hierro, Inc. than other ink (C1, C2, M1, M2) by this example. Since the ink of two kinds of shades is accommodated about cyanogen and magenta, let capacity of Hierro, Inc. be small capacity relatively rather than the quantity which added both of the shade. The capacity of Hierro is good also as capacity equal to the total amount of the ink of other colors, and good also as capacity

equal to each ink of a shade.
[0039]What measured the brightness of each of these color ink was shown in drawing 10. The horizontal axis of drawing 10 is a recording rate over the recording resolution of a printer, and shows the rate which recorded the dot on the white paper P by the ink particles Ip breathed out from the nozzle n. That is, the state where the whole surface of the paper P was covered with the ink particles Ip is shown in the recording rate 100. By this example, since Hierro, Inc. Y2 where dye concentration is high is employed to conventional Hierro, Inc. Y1, this point is explained first. As shown in drawing 10, Hierro, Inc. Y has the highest brightness in three-primary-colors CMY, and brightness L* is the recording rate over 80% as for 100%. Brightness L* said here is the brightness in a CIE1976 L*a*b* color space (CIELAB space).
[0040]In drawing 10, what "-" showed is a relation of the recording rate of Hierro, Inc. Y2 and brightness which made dye concentration 1.5 times to Hierro, Inc. (O) of the usual concentration. It is a point of about 67% of a recording rate by having increased dye concentration 1.5 times that brightness is also falling in proportion to this and usually becomes equal to the brightness of 100% of the recording rate of Hierro, Inc. Y1 of concentration so that it may illustrate.
[0041]In the above, although the relation between the recording rate and brightness L* was explained about each color ink adopted by this example, the relation between a recording rate, hue, and chroma saturation is explained below. Drawing 11 expresses about a*b* the hue and chroma saturation at the time of being a case where it prints in the ink of three colors of Hierro of this example, magenta, and cyanogen, and changing the recording rate of each color into paper among CIE1976 L*a*b* color spaces (CIELAB space). Generally in CIELAB space, it can be considered by making (0, 0) into the starting point that the angle from a horizontal axis expresses hue and the distance from the starting point expresses chroma saturation. In drawing 11, the hue in the case of making the recording rate high 10% respectively and change of chroma saturation can usually be read about CMY ("<>", "**", and "O" express respectively) ink each of concentration.
[0042]On the other hand, Hierro, Inc. ("-" shows in drawing 11) of this example adjusted 1.5 times from conventional ink in the concentration of the color, When concentration is raised 10% respectively, change of chroma saturation (vividness) is larger than the ink of the conventional concentration, and it turns out that it is in agreement with 100% of the recording rate of conventional ink by 66% of a recording rate. Naturally the control range of a dot number becomes narrow. Supposing it considers the matrix of 10x10, the dot up to zero to 66 pieces will be controlled by Hierro [1.5 times the concentration of this], Inc. to the dot up to zero to 100 pieces being controllable by the ink of the conventional concentration.
[0043]When the 3 color ink of the usual concentration is respectively recorded by an equal recording rate, it will sense by gray, but when Hierro, Inc. Y2 of this example is used and the recording rate is made equal to the recording rate of cyanogen or magenta ink, hue will incline toward the Hierro side from gray.
[0044]In this example, although the ink of two kinds of shades is adopted about the cyan ink C and the magenta ink M, the brightness of these ink has the following relation. To the cyan ink C1, the light cyan ink C2, The concentration of the color is considering it as the abbreviation 1/4 by mass percent, and, as for the brightness of both the ink at this time, brightness in case the recording rate of the light cyan ink C2 is 100% is equal to brightness in case the recording rate of the cyan ink C1 is about 35%. This relation is the same also in the magenta ink M1 and the light magenta ink M2. Although the rate of a recording rate that the ink in which concentration differs serves as the same brightness is defined from a point of the beauty of the mixed colors at the time of being intermingled and printing both ink, it is desirable practically to adjust to 20 thru/or 50% of range. If this relation is expressed at a rate of the mass percent of the color in both ink,

As opposed to the mass percent of the color in ink with high concentration (the cyan ink C1 and magenta ink M1), It is almost equivalent to the latter adjusting the relation of the mass percent of the color in ink with low concentration (the light cyan ink C2 and light magenta ink M2) to about 1/5 of the former thru/or about 1/3.

[0045]Next, along with the processing in the half tone module 99 of the printer driver 96, the situation of the dot formation of each color ink in the printer 20 of this example is explained. Although it is printing using shading ink and processing of cyanogen, the dot (dark dot) formation in ink with concentration high about magenta ink, and the dot (light dot) formation in ink with low concentration is needed in the printer 20 of this example, First, below, Hierro, Inc. where concentration is high, and the dot formation usually according to each color of the cyan ink of concentration and magenta ink are explained, and the dot formation by shading ink is explained additionally. Drawing 12 is a flow chart which shows the outline of processing of the half tone module 99 about each color of CMY. In this halftone process, the same processing is fundamentally repeated about each color of CMY so that it may illustrate.

[0046]First, processing which inputs the gradation data about the cyan ink C among the data changed into the gradation data of each color of CYM by the color correction module 98 shown in drawing 8 is performed (Step S100). Since gradation data is expressed by 8 bits, it takes the value of 0 thru/or 255. Next, based on this gradation data, processing which determines turning on and off about the dot of cyan ink is performed with reference to table TC which determines a recording rate (Step S110). An example of the table about each color ink is shown in drawing 13. The determination of turning on and off of the dot about the ink of a certain color can adopt various techniques, for example, the technique and systematic dithering method of error diffusion. The view of error diffusion was adopted in this example. Therefore, after determining turning on and off of a dot based on the cyanogen concentration of the pixel to which its attention is paid, processing of error calculation and error diffusion is performed (Step S120). That is, an error with the concentration expressed by having made the true concentration and dot about the pixel one or OFF is calculated, and processing which attaches and distributes predetermined dignity to the surrounding pixel of the pixel which pays its attention to this is performed. Since predetermined dignity is beforehand attached to the surrounding pixel of the pixel and the error of the shade produced about the processed pixel is beforehand distributed when printing by error diffusion, you read a part for an applicable error and make it reflected in the pixel which is going to print this from now on. It was illustrated to drawing 14 by what weighting this error would be distributed to which surrounding pixel to the pixel PP to which its attention is paid. To the pixel PP to which its attention is paid, to several pixels and several pixels which the transportation direction backside of the paper P adjoins, a density error attaches predetermined dignity (1/4, 1/8, 1/16), and is distributed in the scanning direction of the carriage 30.

[0047]Although the ink of two kinds of shades is prepared and the dot of a shade is formed by this example about the cyan ink C and magenta ink, The facilities of an understanding of this invention which have the feature at the point which made concentration of Hierro, Inc. Y high shall be planned, and dot formation shall be performed about cyanogen and magenta in the following explanation based on drawing 12 only in the ink (equivalent to the thick ink C1 and M1) of the usual concentration.

[0048]The same processing as the next is repeated about magenta ink and Hierro, Inc. after processing of a more than about cyan ink. That is, the gradation data about magenta is inputted (Step S130), turning on and off of the dot of magenta is determined with reference to table TM (Step S140), and error calculation about magenta and processing of error diffusion are performed (Step S150). The gradation data about Hierro is inputted (Step S160), turning on and off of the

dot of Hierro is determined with reference to the table TY (Step S170), and error calculation about Hierro and processing of error diffusion are performed (Step S180). Under the present circumstances, compared with the recording rate about cyanogen and magenta, the recording rate of the dot formation by Hierro, Inc. is reduced by the abbreviation 2/3 according to a difference of the table shown in drawing 13.

[0049]As a result of the recording rate of the dot about Hierro being pressed down by about 2/3 to the recording rate of the dot of ink, such as magenta, the dot of Hierro does not fill a print area thoroughly, even when gradation data is the maximum. Drawing 15 is an explanatory view showing the situation of the dot formation in the maximum [gradation / magenta and / of Hierro] (it is 255 with gradation data). In this example, turning on and off of a dot is determined by making the matrix of 3x3 into a unit with the distributed dither method. Drawing 15 (a) shows that the recording rate is 100 [%], when Hierro, Inc. Y1 of concentration is usually used and gradation data is the maximum. On the other hand, in forming a dot by high-concentration Hierro, Inc. Y2 which used by this example, as it shows in drawing 15 (b), even when gradation data is the maximum (255), only six dots of Hierro, Inc. Y2 are not formed. On the other hand, as the dot of the magenta ink M was shown in drawing 15 (c), nine 3x3 will be formed. As a result, when the dot of both ink is formed, as shown in drawing 15 (d), the magenta ink M will be breathed out by the paper about three dots.

[0050]The result mentioned above is produced by having made dye concentration of Hierro, Inc. into 1.5 times to usual Hierro, Inc. Although the gradation number which the dot formed of Hierro, Inc. can express is usual two thirds, since Hierro, Inc. has high brightness, even if a dot is sparsely formed corresponding to the low-concentration field of an original image, most granulation is not sensed from the first. As a result, the advantage that the total of the dot formed per unit area, i.e., the ink quantity breathed out per unit area, can be reduced without causing the problem of deterioration of the image quality by granulation is acquired. Since a maximum (duty restrictions) exists in the total amount of the ink in which the regurgitation is possible for every paper per unit area, the merit which can reduce required ink quantity is large by making concentration of Hierro, Inc. high. For example, if realizable in cyan ink 100[%]+ magenta ink 100[%]+ Hierro, Inc. 60 [%], composite black, Compared with the duty (300 [%]) at the time of using Hierro, Inc. (the maximum recording rate 100 [%]) of the usual concentration, the margin of about 40 [%] will be born to duty restrictions of a paper. Duty restrictions in the example which outputs dark red on the paper of 190 [%]. If it prints conventionally in the cyanogen 10 [%], the magenta 100 [%], and Hierro 100 [%], in order that the sum total may be set to 210 [%] and may exceed duty restrictions, 10% needed to be transposed to black ink and it needed to print with the magenta 90 [%], Hierro 90 [%], and the black 10 [%]. However, when it transposed to such black ink and having been printed, the dot of conspicuous black was sparsely formed most at high concentration into red, granulation got worse, and image quality was deteriorating. In this example, even if it does not use black ink, it dedicates within duty restrictions in the cyanogen 10 [%], the magenta 100 [%], and Hierro 67 [%], and granulation is good and can obtain a high definition output. That is, if the Hierro concentration is raised like this example, using the margin of the duty restrictions obtained by it, each amount of color ink will be optimized and it will become possible to attain further high definition-ization.

[0051]In this example, since the dye concentration of Hierro, Inc. is raised and the required dot number is reduced, the advantage that a margin produces only the reduced dot number to the overprint of each color ink is also acquired. That the 1/3-about part by which dot formation is not carried out about Hierro, Inc. exists although various devices are made about the lap of ink becomes the merit that the flexibility of the dot arrangement in the overprint of such a plural color can be raised. Saying that there is few formation of the dot by Hierro, Inc. is that the

average amount of consumption of Hierro, Inc. at the time of printing a predetermined area is also referred to as few. As a result, the quantity of Hierro, Inc. which should be carried in the ink cartridge 70 can also be reduced. If ink quantity is reduced, the dignity of the cartridge 70 can be reduced and the mechanism in which the cartridge 70 is conveyed can also be simplified. The part which reduced the capacity of Hierro, Inc., and other ink quantity can also be increased. Since the quantity of shading ink can be increased like this example when using the ink of two kinds of shades, the merit is large.

[0052]In the above, with this printer 20, although the example of this invention was described, since the ink of two kinds of shades is used, proper use of the ink of two kinds of shades about magenta and cyanogen is explained briefly. It is judged whether the processing (Step S110) for which it opts about turning on and off of the dot of cyanogen C ink with reference to table TC, and the processing (Step S140) for which it opts about magenta similarly form a dot about the ink of two kinds of shades in detail.

[0053]In both steps, processing which determines turning on and off of a dark dot is performed based on gradation data DS inputted first. The details of the processing which determines turning on and off of this dark dot were shown in the dark dot formation judging process routine of drawing 17. In this manipulation routine, processing which generates the dark level data Dth with reference to the table of drawing 18 based on gradation data DS is performed first (Step S222). Drawing 18 shows the table which sets up into how much the recording rate of light ink and thick ink is made to the gradation data of the original picture. gradation data takes the value to 0-255 about each color -- since the thing is carried out (8 bits of each color), the size of gradation data is expressed like 16 / 256 grades below. When the table of drawing 18 shows the rate of the thick ink in the printed matter obtained eventually, and light ink and a certain gradation data is given, The recording rate of thick ink and the recording rate of light ink are given to a meaning, and turning on and off of the dot by the thick ink or light ink of a pixel to which its attention is paid is not defined. If this relation is explained briefly, in this example, turning on and off of a dark dot will be first judged using this table, and turning on and off of a light dot will be judged with reference to that result. Therefore, the recording rate of a light dot depends on the following reason [being in agreement with the table shown in drawing 18].

[0054]The number of the dark dot formed there and light dots can express the concentration of the picture per unit area. According to drawing 18, the case where concentration is the maximum about the number of the dark dots formed per unit area is considered as a rate over this as the value 255, and this is set to Ks. The number of light dots is similarly set to Us. It will be set to DS=Ksx (evaluation value of a dark dot) / 255+Usx (evaluation value of a light dot) / 255 if it is going to make it equal to gradation data DS of a picture which inputted the concentration of the picture formed at this time. Since it can consider that the evaluation value (thickness of the formed dot) of a dark dot is 255, the table of the light dot shown in drawing 18 will be decided by how many the evaluation value of the table of a dark dot and a light dot is taken. If the data of the point (18 and light dot data are [gradation data] 122 in 95 and dark dot data) that the recording rate of a light dot serves as the maximum, for example is inputted into an upper type in the example shown in drawing 18, A light dot evaluation value is set to Z, it is set to 95=18x255/255+122xZ/255, and a light dot evaluation value is set to 160. This dark dot evaluation value and a light dot evaluation value are the same as what is treated as result value RV with the flow chart of the determination technique of turning on and off of a dark dot and a light dot mentioned later.

[0055]Based on inputted gradation data DS, the dark level data Dth corresponding to the recording rate of the thick ink defined beforehand is obtained by referring to the table of drawing 18 (drawing 18 right-hand side vertical axis). For example, when the inputted gradation data of

cyanogen prints 50/256 of solid fields, the recording rate of the cyan ink C1 which is thick ink is 0%, and dark level data also serves as the value 0. When gradation data prints 95/256 of solid fields, the recording rate of the cyan ink C1 which is thick ink is 7%, and the dark level data Dth serves as the value 18. When gradation data prints 191/256 of solid fields, the recording rate of the cyan ink C1 is 75%, and dark level data serves as the value 191. If turning on and off of a light dot is judged by the technique later mentioned in these cases, the recording rate of the light cyan ink C2 which is light ink will be 36%, 58%, and 0%, respectively.

[0056]Next, it is judged whether the dark level data Dth obtained in this way is larger than threshold Dref1 (Step S224). This threshold Dref1 is a decision value of whether to form the dot by thick ink in the pixel to which its attention was paid, and it can also be simply fixed about [of the maximum of the dark level data Dth] to 1/2. In this example, the threshold matrix of the distributed dither was adopted as setting out of this threshold, especially, about 64x64 global matrix (blue noise matrix) was used, systematic dithering method was applied, and the distributed type matrix was adopted as a threshold. Therefore, threshold Dref1 which defines turning on and off of a dark dot becomes a different value for every pixel to which its attention is paid. A distributed type threshold matrix has the high spatial frequency of the dot determined by the threshold matrix, and a dot says in a field the type by which it is generated scatteringly. Specifically, the Beyer type threshold matrix etc. are known. Since generating of a dark dot will be scatteringly performed if a distributed type dither is adopted, distribution of a shade dot does not incline but image quality improves.

[0057]When the dark dot data Dth are larger than threshold Dref1, it judges that the dark dot of the pixel is made one, and also processing which calculates result value RV is performed (Step S226). Result value RV is a value (dark dot evaluation value) equivalent to the concentration of the pixel, and when a dark dot judges that the dot in ink with high concentration is formed in one, i.e., the pixel, the value (for example, value 255) to which the concentration of the pixel was equivalent is set up. This result value RV may be set up as a function of the dark level data Dth, although a fixed value may be sufficient.

[0058]On the other hand, when the dark level data Dth is the one or less threshold Dref, it judges that a dark dot is not turned off namely, formed, and also processing which assigns the value 0 to result value RV is performed (Step S228). Since the white ground of a paper remains, the part in which the dot in ink with high concentration is not formed makes result value RV the value 0.

[0059]In this way, turning on and off of a dark dot is determined, and after performing processing which calculates result value RV, as shown in drawing 17 below, processing which calculates amendment data DC which added diffusion-errors **Du from the pixel nearby [whose] has been processed is first performed to gradation data DS of the pixel to which its attention is paid (Step S240). This is for processing error diffusion. Then, when it judges whether the dark dot was considered as one (dot formation by the cyan ink C1) (Step S242) and the dark dot is not formed. Processing which determines turning on and off of a dot with low concentration, i.e., the dot in the light cyan ink C2, (it is hereafter called a light dot) is performed (Step S 244 or less processing).

[0060]It is judged whether formation of the dot in the light cyan ink C2 has gradation data DC larger than threshold Dref2 for light dots which applied this error diffusion method and was amended by the view of error diffusion in the example (Step S244). This threshold Dref2 is a decision value of whether to form the dot by light ink with low concentration in the pixel to which its attention was paid, and it was set up by this example as a value changed according to amended data DC.

[0061]If amendment data DC is larger than threshold Dref2, one [a light dot] will be judged and result value RV (light dot evaluation value) will be calculated (Step S246). By this example,

result value RV made the value 122 the reference value, and was taken as the value amended by amendment data DC. On the other hand, when amendment data DC is judged to be the two or less threshold Dref, it judges that a light dot is turned OFF and processing which includes the value 0 in result value RV is performed (Step S248).

[0062]In this way, although record by the light dot and a dark dot will be performed, drawing 19 showed this situation typically about the cyan ink C1 and the light cyan ink C2. The field where the inputted gradation data is low (in an example.) Gradation data in the field of 0 / 256 - 63/256. As shown in drawing 19 (a) and (b), only the dot in the light cyan ink C2 is formed, And the rate of the light dot which exists in a predetermined field increases (drawing 19 (c) thru/or (e)), if gradation data becomes still higher, formation of a light dot will no longer be performed and only a dark dot will be formed, as gradation data becomes high (drawing 19 (f), (g)). If gradation data serves as the maximum, as shown in drawing 19 (h), the recording rate by a dark dot will be 100%.

[0063]In the printer 20 of this example explained above, while employing Hierro, Inc. where dye concentration is higher than usual, Carry the ink cartridge 70 which has cyan ink of two kinds of shades, and magenta ink in the carriage 30, and the gradation of an inputted image in a low field. Since it prints using the low light cyan ink and light magenta ink of dye concentration, the granular feeling in the field where gradation is low is not conspicuous, and the advantage that print quality is very high is acquired. Since concentration of Hierro, Inc. can be made high in the range in which the granular feeling about the dot of Hierro, Inc. is not conspicuous, its about 4 times are possible at dye concentration. At this time, the average discharge quantity of Hierro, Inc. can be reduced substantially.

[0064]It is not limited to Hierro, Inc. and what is necessary is just to raise the concentration of ink with the highest brightness, or ink with the lowest visibility of granulation in the combination of the color of the ink used for printing in the above-mentioned example, although concentration of Hierro, Inc. was made high. Although correction of the bias of the color balance by having raised the dye concentration of Hierro, Inc. was performed by making the rate of the dot formation of Hierro, Inc. low in this example, this bias is correctable also by reducing the path of the dot formed of Hierro, Inc. The size of the dot formed on the paper P is controllable by adjusting the strength (voltage and duration time) etc. of the voltage pulse which carries out a seal of approval to the diameter and piezo-electric element PE of a nozzle for ink discharge. For example, what is necessary is to form the nozzle 66 for Hierro, Inc. of the above-mentioned example as a nozzle for byway dots, and just to form the nozzles 62 and 63 for cyan ink C, the nozzle 64 for magenta ink M, and a logo as a nozzle for major-diameter dots.

[0065]Although the program which controls formation of each color dots was prepared for the printer driver [not the printer 20 but] 96 side of the computer 90 in above-mentioned this example, preparing in the printer 20 is also possible. For example, from the computer 90, when the picture information printed with languages, such as PostScript, is sent, it will have the half tone module 99 etc. in the printer 20 side. The software program which realizes these functions is memorized by the hard disk in the computer 90, etc., when the computer 90 starts it, it is included in an operating system with the gestalt of a printer driver at this example, but. It is also possible for it to be stored in portable storage media (portability type storage), such as a floppy disk and CD-ROM, and to be transmitted to the main memory or the external storage of a computer system from a portable storage medium. It is also possible to consider it as the gestalt which is transmitted to the inside of the printer 20 and is used for it from the computer 90. The device which provides the software program of this can be formed via a communication line, and it can also be considered as the gestalt which transmits and uses the contents of processing of the above-mentioned half tone module for this computer and printer 20 via a communication line.

[0066]In the example mentioned above, when any regurgitation of the ink of a shade carries out the seal of approval of the voltage of specified time width to piezo-electric element PE using piezo-electric element PE, it is carrying out, but it is also easy to adopt other ink discharge methods. As an ink discharge method put in practical use, if it divides roughly, ink particles will be separated from the continuous ink jet, and it will be divided roughly into the method on demand which are a method which carries out the regurgitation, and a method adopted also in the example mentioned above. The micro dot method etc. which use for printing the very small satellite particles produced when major-diameter particles are divided in the former from the jet of the electrification modulation method in which a drop is disunited from the jet of ink by electrification abnormal conditions, and ink are known. These methods are also applicable to the printer of this invention using the ink of two or more kinds of concentration.
[0067]When ink particles are [method on demand] needed by a dot unit, As ink particles are generated and it is shown in drawing 20 (A) - (E) besides the method using the piezo-electric element adopted in the example mentioned above, Heating element HT is provided near the nozzle NZ of ink, the bubble BU is generated by heating ink, and the method etc. which carry out the regurgitation of ink particle IQ with the pressure are known. The ink discharge method of these methods on demand is also applicable to the printer of this invention using several dots from which the ink of two or more kinds of concentration or a path differs. In addition to this, the view referred to as making high concentration of the highest ink of brightness or ink with the lowest visibility of granulation is applicable also to the color printer of electrophotographying systems, such as a color printer of a hot printing method, and laser.

TECHNICAL FIELD

[Field of the Invention]It is intermingled in this invention.
Therefore, it has a head which can record three or more kinds of ink which can express the hue of a prescribed range, and is related with the ink cartridge used for the printer, the printing method, and this which can record the picture of multi-tone in the ink recorded on printed matter by this head.

PRIOR ART

[Description of the Prior Art]In recent years, as an output unit of a computer, the color printer of the type which records the ink of several colors on printed matter by a head spreads widely, and it is widely used for printing the picture which the computer etc. processed with multicolor multi-tone. The hot printing method which fuses the ink on an ink ribbon and is transferred in a paper as a method of recording ink on printed matter, Various techniques, such as an inkjet method which turns the solution of color ink to a paper and carries out the regurgitation, and an electrophotographying system which forms a latent image on a photo conductor with laser, and transfers color toner, are known. In reproducing the color of the range of predetermined hue in any case and carrying out full color printing to it by intermingling the ink of several kinds of colors, it usually uses the ink of three colors of cyanogen, magenta, and yellow (CMY).
[0003]Some methods can be considered for it to form the picture of multi-tone when printing a multicolor picture in two or more kinds of such ink. One is a technique adopted with the conventional printer.
The density (frequency of occurrence per unit area) of a dot expresses the gradation of the

picture printed, seting as constant the size of the dot formed on a paper in the ink which carries out the regurgitation at once.
Another method adjusts the dot diameter formed on a paper, and changes the concentration per unit area. These days, micro processing of the head which forms ink particles progresses, and density of a dot, a variable range of a dot diameter, etc. which can be formed per predetermined length are improving every year.

EFFECT OF THE INVENTION

[The means for solving a technical problem, and its operation and effect] The following composition was used for the invention in this application in order to attain this purpose. First, in a printer provided with a head recordable on printed matter for three or more kinds of ink which can express hue of a prescribed range when the 1st printer of this invention was intermingled, The ratio of concentration of ink with the highest brightness per same recording rate among said each color ink, and other ink, It has this each color ink so that color balance when a recording rate per unit area of these ink is made equal may incline toward the ink side with this highest brightness, and it is making into a gist to have a compensation means which amends recording quantity of ink with this highest brightness to a ratio which corrects this bias.
[0007]The 1st printing method of this invention is provided with a head recordable on printed matter for three or more kinds of ink which can express hue of a prescribed range by being intermingled, It is the method of controlling distribution of a dot of this ink beyond 3 kind based on a gradation signal of a picture which it is going to print, and printing a picture of multi-tone, The ratio of concentration of ink with the highest brightness per same recording rate among said each color ink, and other ink, It sets up so that color balance when a recording rate per unit area of these ink is made equal may incline toward the ink side with this highest brightness, and it is making into a gist to amend recording quantity of ink with this highest brightness to a ratio which corrects this bias.
[0008]By being intermingled, this printer and printing method are provided with a head which can record three or more kinds of ink which can express hue of a prescribed range, and form various hue and a picture of brightness (concentration) by forming a dot in these ink at a predetermined rate. He loses purposely color balance when a recording rate per unit area of each color ink is made equal, and is trying for color balance to incline toward the ink side with the highest brightness per same recording rate with a printer of this invention in that case. Therefore, if a recording rate per unit area is made the same, since color balance inclines toward the ink side with the highest brightness, it will amend recording quantity of ink with the highest brightness to a ratio which corrects this bias by a compensation means. As a result, a total amount of all the ink recorded can be reduced, without spoiling quality of a picture formed, since recording quantity of ink which color balance becomes normal, and its brightness is the highest, and has little influence of granulation by low concentration is reduced.
[0009]In a printer provided with a head recordable on printed matter for three or more kinds of ink which can express hue of a prescribed range when the 2nd printer of this invention was intermingled, The ratio of concentration of ink with the lowest visibility of granulation at the time of considering it as the same recording rate among said each color ink, and other ink, It has this each color ink so that it may incline toward the ink side with the lowest visibility of this granulation of color balance when a recording rate per unit area of these ink is made equal, and it is making into a gist to have a compensation means which amends recording quantity of ink with the lowest visibility of this granulation to a ratio which corrects this bias.

[0010]The 2nd printing method of this invention is provided with a head recordable on printed matter for three or more kinds of ink which can express hue of a prescribed range by being intermingled, It is the method of controlling distribution of a dot of this ink beyond 3 kind based on a gradation signal of a picture which it is going to print, and printing a picture of multi-tone, The ratio of concentration of ink with the lowest visibility of granulation at the time of considering it as the same recording rate among said each color ink, and other ink, It sets up incline toward the ink side with the lowest visibility of this granulation of color balance when a recording rate per unit area of these ink is made equal, and is making into a gist to amend recording quantity of ink with the lowest visibility of this granulation to a ratio which corrects this bias.
[0011]In this printer and printing method, like the 1st printer and the 1st printing method, By being intermingled, it has a head which can record three or more kinds of ink which can express hue of a prescribed range, and various hue and a picture of brightness (concentration) are formed by forming a dot in these ink at a predetermined rate. He loses purposely color balance when a recording rate per unit area of each color ink is made equal, and is trying for color balance to incline toward the ink side with the lowest visibility of granulation at the time of considering it as the same recording rate with a printer of the 2nd invention in that case. Therefore, if a recording rate per unit area is made the same, since color balance inclines toward the ink side with the lowest visibility of granulation, it will amend recording quantity of ink with the lowest visibility of granulation to a ratio which corrects this bias by a compensation means. As a result, a total amount of all the ink recorded can be reduced, without spoiling quality of a picture formed, since color balance becomes normal and recording quantity of ink with the low visibility of granulation is reduced.
[0012]It is practical to choose Hierro as ink with the highest brightness or ink with the lowest visibility of granulation practical [adopting ink of Hierro as what is called the three primary colors, magenta, and cyanogen] as three or more kinds of ink in such a printer. What is necessary is from the first, just to choose ink with the highest brightness, or ink with the lowest visibility of granulation in those colors in the case of combination of other colors.
[0013]Although the technique toward which color balance of combination of each color ink is biased can consider various approaches, It is making dye concentration of the ink with the highest brightness as one, or ink with the lowest visibility of granulation higher in the 1.1 thru/or 4 times as many ranges than concentration which balances when a recording rate per unit area of three or more kinds of ink is equal. Granulation will be sensed, if an effect by concentration having raised concentration in less than 1.1 times cannot be expected but it is made higher than 4 times. Since adjustment of dye concentration is easy, it can be easily made into a bias of a request of color balance.
[0014]In this case, amendment of recording quantity of ink with the highest brightness or ink with the lowest visibility of granulation can be attained by reducing a rate of formation of a dot in this ink. It is possible to reduce a path of a dot in this ink as the technique of other amendments.
[0015]Making beforehand larger than a dot diameter of other ink a dot diameter of ink with the highest brightness as one of the techniques toward which color balance of combination of each color ink is biased beforehand, or ink with the lowest visibility of granulation is also considered. A compensation means in this case can be amended by reducing a rate of dot formation.
[0016]As a method recorded on printed matter, three or more kinds of ink, Can apply an all directions type known from the former, and for example, three or more kinds of each ink, A solution which shall provide a solvent with a color or paints as melting or a dispersed solution, and contains these color or paints for a head can be used as a head which carries out the

regurgitation to this printed matter, and a compensation means can be made into a means which amends discharge quantity of ink. The technique of carrying out the regurgitation of the solution form ink can form a detailed dot at comparatively high speed, and is preferred.
[0017]In a printer using such solution form ink, about ink other than ink in which amendment of discharge quantity is made among three or more kinds of ink. It shall have ink of concentration of two or more kinds of shades, and said head can also be made possible for regurgitation of ink with said said highest brightness, or ink with the lowest visibility of granulation with ink of concentration of two or more kinds of these shades. That is, about ink whose visibility of granulation is to some extent high, light ink with low concentration is prepared and granulation of a field where concentration is low is prevented.
[0018]When combination of a color is Hierro, magenta, and cyanogen as this shading ink, It is also preferred from points, such as nature of a concentration change of a mixture part of shading ink, to have ink of two or more kinds of shades about magenta and cyanogen, and to set dye concentration of low concentration ink of each color to abbreviated 1 / 4 of dye concentration of high concentration ink.
[0019]The technique of formation of a dot of each color shall determine existence of a dot by said each color ink, for example with a dither method, although various techniques are permitted. When adopting such a dither method, a threshold matrix which defines turning on and off of a dot can be made into a distributed type threshold matrix. If a distributed type threshold matrix is used, it is advantageous from a point of dot formation in which dot distribution is distributed and it is hard to impress granulation.
[0020]A mechanism of dot formation in such a printer shall equip a head with a mechanism which carries out the regurgitation of the ink particles with a pressure given to ink by impression of voltage to an electrostriction element provided in an ink passage, for example, although various things are known. Or composition provided with a mechanism which carries out the regurgitation of the ink particles with a pressure given to ink of this ink passage with air bubbles by which it is generated by energization to a heating element provided in an ink passage can also be taken.
[0021]What equips with an ink cartridge of this invention a printer mentioned above, and is used, Or it is used for a printing method mentioned above, and three or more kinds of ink which can express hue of a prescribed range is stored by being intermingled, About ink with said highest brightness among this ink beyond 3 kind, or ink with the lowest visibility of granulation. The dye concentration is set up compared with other ink more highly than concentration which balances when a recording rate per unit area is equal, and it is making to have made the capacity into capacity equivalent to capacity of other ink, or small into a gist.
[0022]In a printer and a printing method which were mentioned above, concentration of ink with the highest brightness per same recording rate or ink with the lowest visibility of granulation is raised, and the volume amount used is reduced. Therefore, a period until it exhausts each color ink can be made comparable by making capacity of ink with the highest brightness per same recording rate, or ink with the lowest visibility of granulation into capacity equivalent to other ink, or small.
[0023]In two or more kinds of shades preparing ink other than ink with the highest brightness, or ink with the lowest visibility of granulation, Since the amount of shade each ink used itself decreases, an ink cartridge which made capacity of ink with the highest brightness or ink with the lowest visibility of granulation larger than ink capacity of shade each of these colors is also useful.
[0024]
[Other modes of an invention] This invention contains other following modes. The 1st mode is

composition which puts some means of a printer on the device side which outputs not an inside of a case but a picture which it is going to print of a printer. It is realizable by a discrete circuit, and a compensation means is realizable also with software in an arithmetic logic operation circuit centering on CPU. To processing about generation of a dot, make it carry out to a side which outputs a picture which it is going to print in the case of the latter, for example, a computer, and in a case of a printer, A gestalt which stores only a mechanism which controls regurgitation of ink from a head and forms a generated dot on a paper etc. can also be considered.
[0025]The 2nd mode of this invention is a gestalt as a portable storage medium which recorded software which is loaded to a computer system and performed, An arithmetic logic operation circuit (hardware) centering on CPU and a software program executed on it shall realize at least a part of means to perform processings, such as the above-mentioned compensation means. At least a part of that software program is stored in this portable storage medium.
[0026]The 3rd gestalt is a gestalt as a feed unit which supplies the above-mentioned software program via a communication line.
[0027]There is an invention of an ink cartridge used for a printer mentioned above as the 4th gestalt. For example, when a printer of this invention color-prints using two or more color ink, an ink cartridge which stores three or more kinds of color ink in a container of a different body with black ink can be considered. black ink used for printing of a stage of that exchange centering on the usual character since this ink cartridge is stored by container different from black ink -- it is not influenced at skilled exhaustion and its exchange time.
[0028]
[Embodiment of the Invention]Next, an embodiment of the invention is described based on an example. Drawing 1 is an outline lineblock diagram of the printer 20 which is one example of this invention. The mechanism in which this printer 20 conveys the paper P with the paper feed motor 22 so that it may illustrate, The mechanism in which the carriage 30 is made to reciprocate to the shaft orientations of the platen 26 with the carriage motor 24, It comprises the control circuit 40 which manages an exchange of the signal of the mechanism which drives the printhead 28 carried in the carriage 30, and controls the regurgitation and dot formation of ink, and these paper feed motors 22, the carriage motor 24, the printhead 28 and the navigational panel 32.
[0029]The mechanism in which the paper P is conveyed is provided with the gear train which transmits rotation of the paper feed motor 22 not only to the platen 26 but to the paper conveyance roller which is not illustrated (graphic display abbreviation). The mechanism in which the carriage 30 is made to reciprocate, It comprises position detection sensor 39 grade which detects the sliding shaft 34 which is constructed in parallel with the axis of the platen 26, and holds the carriage 30 so that sliding is possible, the belt pulley 38 which stretches the endless driving belt 36 between the carriage motors 24, and the home position of the carriage 30.
[0030]Drawing 2 showed the composition of this printer 20 centering on the control circuit 40. illustrating -- as -- this -- a control circuit -- 40 -- common knowledge -- CPU -- 41 -- a program -- etc. -- having memorized -- P-ROM -- 43 -- RAM -- 44 -- a character -- a dot matrix -- having memorized -- a character generator -- (-- CG --) -- 45 -- etc. -- a center -- carrying out -- arithmetic logic operation -- a circuit -- ****** -- constituting -- having -- **** -- in addition. It has the I/F dedicated communication circuit 50 which performs an interface with an external motor etc. for exclusive use, the head drive circuit 52 which is connected to this I/F dedicated communication circuit 50, and drives the head 28, and the motor drive circuit 54 which similarly drives the paper feed motor 22 and the carriage motor 24. The parallel interface circuit is built in, it is connected to a computer via the connector 56, and the I/F dedicated communication circuit 50 can receive the signal for printing which a computer outputs. The output of the picture signal from a computer is mentioned later.

[0031]Next, the regurgitation principle of the ink by the concrete composition of the carriage 30 and the printhead 28 carried in the carriage 30 is explained. Drawing 3 is a perspective view showing the shape of the carriage 30. Drawing 4 is a top view showing the nozzle part which carries out the regurgitation of each color ink in the printhead 28 arranged by the lower part of the carriage 30. As shown in drawing 3, the carriage 30 is carrying out the shape of approximately L type, and is provided with the divider plate 31 into which loading of the cartridge for black ink and the cartridge 70 (refer to drawing 5) for color ink which are not illustrated is possible, and both cartridges are divided so that wearing is possible. A total of six heads 61 thru/or 66 for ink discharge are formed in the printhead 28 of the lower part of the carriage 30, and the introducing pipes 71 thru/or 76 which lead the ink from an ink tank to each of this head for colors are set up by the pars basilaris ossis occipitalis of the carriage 30. If the carriage 30 is equipped with the cartridge and the cartridge 70 for color ink for black ink from the upper part, the introducing pipes 71 thru/or 76 will be inserted in the connecting hole established in each cartridge.

[0032]The mechanism in which ink is breathed out is explained briefly. If the carriage 30 is equipped with the cartridge 70 for ink as shown in drawing 6, using capillarity, the ink in the cartridge for ink will be sucked out via the introducing pipes 71 thru/or 76, and will be led to each color heads 61 thru/or 66 of the printhead 28 provided in the carriage 30 lower part. When equipped with an ink cartridge for the first time, operation which attracts ink on each color heads 61 thru/or 66 with a pump for exclusive use is performed, but in this example, a graphic display and explanation are omitted for the printhead 28 about the composition of a wrap cap etc. at the time of the pump for suction, and suction.

[0033]As shown in drawing 4 and drawing 6, in each color heads 61 thru/or 66, the 32 nozzles n are formed for every color, and piezo-electric element PE which is one of the electrostriction elements and was excellent in the response for every nozzle is arranged at them. Drawing 7 showed the structure of piezo-electric element PE and the nozzle n in detail. Piezo-electric element PE is installed in the position which touches the ink passage 80 to which ink is led to the nozzle n so that it may illustrate. Piezo-electric element PE is an element which a crystal structure is distorted by impression of voltage and changes electric-mechanical energy at very high speed as everyone knows. In this example, by impressing the voltage of specified time width to inter-electrode [which was provided in the both ends of piezo-electric element PE], as shown in the drawing 7 lower berth, piezo-electric element PE elongates only the applying time of voltage, and changes one side attachment wall of the ink passage 80. As a result, it contracts according to extension of piezo-electric element PE, the ink equivalent to a part for this contraction serves as the particles Ip, and the volume of the ink passage 80 is breathed out at high speed from the tip of the nozzle n. Printing will be performed when this ink particle Ip sinks into the paper P with which the platen 26 was equipped.

[0034]The arrangement of each color heads 61 thru/or 66 in the printhead 28 is divided and allocated in 3 sets by making two heads into a lot, as shown in drawing 4 on the relation which arranges piezo-electric element PE mentioned above. The head 61 for black ink is allocated by the end of the side close to the cartridge for black ink, and the next door is the ink head 62 for cyanogen. the ink (it is hereafter called Light cyan, Inc.) whose concentration is lower than the cyan ink in which adjoining this group is supplied to the ink head 62 for cyanogen -- they are the head 63 of business, and the ink head 64 for magentas. the ink (it is hereafter called light magenta ink) in the next group whose concentration is lower than usual magenta ink -- the head 65 of business and the head 66 for Hierro are arranged. A presentation and concentration of each ink are mentioned later.

[0035]The printer 20 of this example which has the hardware constitutions explained above,

Rotating platen 26 and other rollers with the paper feed motor 22, and conveying the paper P.The carriage 30 is made to reciprocate with the carriage motor 24, piezo-electric element PE of each color heads 61 thru/or 66 of the printhead 28 is driven simultaneously, the regurgitation of each color ink is performed, and a multicolor picture is formed on the paper P. The printer 20 forms a multicolor picture based on the signal received from image forming devices, such as the computer 90, via the connector 56, as shown in drawing 8. In this example, the application program which is operating by computer 90 inside shows the picture to CRT display 93 via the video driver 91, processing a picture. If this application program 95 publishes a printing instruction, the printer driver 96 of the computer 90 would receive picture information from the application program, and will have changed this into the signal which can print the printer 20. In the example shown in drawing 8, inside the printer driver 96, As opposed to the rasterizer 97 which changes into the sexual desire news of a dot unit the picture information which the application program 95 is treating, and the picture information (gradation data) changed into the sexual desire news of the dot unit. By the existence of the ink in a dot unit from the color correction module 98 which performs color correction according to the characteristic of coloring of an image output device (here printer 20), and the picture information after color correction was carried out. It has the half tone module 99 which generates the so-called picture information of the half-tone expressing the concentration in a certain area. Since operation of each of these modules is a well-known thing, explanation is omitted in principle and the contents of the half tone module 99 are later mentioned for it.

[0036]As explained above, the printer 20 of this example equips the printhead 28 with the head in which the regurgitation is possible for each color ink. Hierro, Inc. Y and the black ink K which are breathed out by this head make the rate of a color 2.7 mass percents and 4.8 mass percent, respectively, using direct IERO 86 and the food black 2 as a color, as that ingredient was shown in drawing 9. The heads 63 and 65 for Light cyan, Inc. and light magenta ink are formed in the printhead 28 in addition to the ink of four so-called colors of CMYK containing this Hierro and black. These light cyan ink and light magenta ink make low dye concentration of usual cyan ink and magenta ink, as shown in drawing 9.

[0037]Usually so that it may illustrate the cyan ink (shown in [C1] drawing 9) of concentration, As opposed to using 3.6 mass percents, a 30 mass percent diethylene glycol, and SAFI Norian 465 as 1 mass percent and 65.4 mass percent water for the direct blue 99 which is a color, Direct blue 99 which is light cyan ink (shown in [C2] drawing 9) and a color is made into 0.9 mass percents which are 1/4 of the cyan ink C1, for viscosity control, a diethylene glycol is changed into 35 mass percents, and water is changed into 63.1 mass percents. Usually the magenta ink (shown in [M1] drawing 9) of concentration, As opposed to using 2.8 mass percents, a 20 mass percent diethylene glycol, and SAFI Norian 465 as 1 mass percent and 79 mass percent water for the acid red 289 which is a color, Light magenta ink (shown in [M2] drawing 9) changes the acid red which is a color into 0.7 mass percents, the 25 mass percent diethylene glycol, and 74 mass percent water which are 1/4 of the magenta ink M1. As for any ink, viscosity is adjusted to about 3 [mPa-s] grade. In this example, since surface tension besides the viscosity of each color ink is adjusted identically, it does not depend on the ink which forms a dot, but control of piezo-electric element PE for every color head can be made the same.

[0038]2 and Y are stored among these ink in the color ink [except black] C1, C2, M1, and M ink cartridge 70 shown in drawing 5, and the capacity is made into what has more Hierro, Inc. than other ink (C1, C2, M1, M2) by this example. Since the ink of two kinds of shades is accommodated about cyanogen and magenta, let capacity of Hierro, Inc. be small capacity relatively rather than the quantity which added both of the shade. The capacity of Hierro is good also as capacity equal to the total amount of the ink of other colors, and good also as capacity

equal to each ink of a shade.
[0039]What measured the brightness of each of these color ink was shown in drawing 10. The horizontal axis of drawing 10 is a recording rate over the recording resolution of a printer, and shows the rate which recorded the dot on the white paper P by the ink particles Ip breathed out from the nozzle n. That is, the state where the whole surface of the paper P was covered with the ink particles Ip is shown in the recording rate 100. By this example, since Hierro, Inc. Y2 where dye concentration is high is employed to conventional Hierro, Inc. Y1, this point is explained first. As shown in drawing 10, Hierro, Inc. Y has the highest brightness in three-primary-colors CMY, and brightness L* is the recording rate over 80% as for 100%. Brightness L* said here is the brightness in a CIE1976 L*a*b* color space (CIELAB space).
[0040]In drawing 10, what "-" showed is a relation of the recording rate of Hierro, Inc. Y2 and brightness which made dye concentration 1.5 times to Hierro, Inc. (O) of the usual concentration. It is a point of about 67% of a recording rate by having increased dye concentration 1.5 times that brightness is also falling in proportion to this and usually becomes equal to the brightness of 100% of the recording rate of Hierro, Inc. Y1 of concentration so that it may illustrate.
[0041]In the above, although the relation between the recording rate and brightness L* was explained about each color ink adopted by this example, the relation between a recording rate, hue, and chroma saturation is explained below. Drawing 11 expresses about a*b* the hue and chroma saturation at the time of being a case where it prints in the ink of three colors of Hierro of this example, magenta, and cyanogen, and changing the recording rate of each color into paper among CIE1976 L*a*b* color spaces (CIELAB space). Generally in CIELAB space, it can be considered by making (0, 0) into the starting point that the angle from a horizontal axis expresses hue and the distance from the starting point expresses chroma saturation. In drawing 11, the hue in the case of making the recording rate high 10% respectively and change of chroma saturation can usually be read about CMY ("<>", "**", and "O" express respectively) ink each of concentration.
[0042]On the other hand, Hierro, Inc. ("-" shows in drawing 11) of this example adjusted 1.5 times from conventional ink in the concentration of the color, When concentration is raised 10% respectively, change of chroma saturation (vividness) is larger than the ink of the conventional concentration, and it turns out that it is in agreement with 100% of the recording rate of conventional ink by 66% of a recording rate. Naturally the control range of a dot number becomes narrow. Supposing it considers the matrix of 10x10, the dot up to zero to 66 pieces will be controlled by Hierro [1.5 times the concentration of this], Inc. to the dot up to zero to 100 pieces being controllable by the ink of the conventional concentration.
[0043]When the 3 color ink of the usual concentration is respectively recorded by an equal recording rate, it will sense by gray, but when Hierro, Inc. Y2 of this example is used and the recording rate is made equal to the recording rate of cyanogen or magenta ink, hue will incline toward the Hierro side from gray.
[0044]In this example, although the ink of two kinds of shades is adopted about the cyan ink C and the magenta ink M, the brightness of these ink has the following relation. To the cyan ink C1, the light cyan ink C2, The concentration of the color is considering it as the abbreviation 1/4 by mass percent, and, as for the brightness of both the ink at this time, brightness in case the recording rate of the light cyan ink C2 is 100% is equal to brightness in case the recording rate of the cyan ink C1 is about 35%. This relation is the same also in the magenta ink M1 and the light magenta ink M2. Although the rate of a recording rate that the ink in which concentration differs serves as the same brightness is defined from a point of the beauty of the mixed colors at the time of being intermingled and printing both ink, it is desirable practically to adjust to 20 thru/or 50% of range. If this relation is expressed at a rate of the mass percent of the color in both ink,

As opposed to the mass percent of the color in ink with high concentration (the cyan ink C1 and magenta ink M1), It is almost equivalent to the latter adjusting the relation of the mass percent of the color in ink with low concentration (the light cyan ink C2 and light magenta ink M2) to about 1/5 of the former thru/or about 1/3.

[0045]Next, along with the processing in the half tone module 99 of the printer driver 96, the situation of the dot formation of each color ink in the printer 20 of this example is explained. Although it is printing using shading ink and processing of cyanogen, the dot (dark dot) formation in ink with concentration high about magenta ink, and the dot (light dot) formation in ink with low concentration is needed in the printer 20 of this example, First, below, Hierro, Inc. where concentration is high, and the dot formation usually according to each color of the cyan ink of concentration and magenta ink are explained, and the dot formation by shading ink is explained additionally. Drawing 12 is a flow chart which shows the outline of processing of the half tone module 99 about each color of CMY. In this halftone process, the same processing is fundamentally repeated about each color of CMY so that it may illustrate.

[0046]First, processing which inputs the gradation data about the cyan ink C among the data changed into the gradation data of each color of CYM by the color correction module 98 shown in drawing 8 is performed (Step S100). Since gradation data is expressed by 8 bits, it takes the value of 0 thru/or 255. Next, based on this gradation data, processing which determines turning on and off about the dot of cyan ink is performed with reference to table TC which determines a recording rate (Step S110). An example of the table about each color ink is shown in drawing 13. The determination of turning on and off of the dot about the ink of a certain color can adopt various techniques, for example, the technique and systematic dithering method of error diffusion. The view of error diffusion was adopted in this example. Therefore, after determining turning on and off of a dot based on the cyanogen concentration of the pixel to which its attention is paid, processing of error calculation and error diffusion is performed (Step S120). That is, an error with the concentration expressed by having made the true concentration and dot about the pixel one or OFF is calculated, and processing which attaches and distributes predetermined dignity to the surrounding pixel of the pixel which pays its attention to this is performed. Since predetermined dignity is beforehand attached to the surrounding pixel of the pixel and the error of the shade produced about the processed pixel is beforehand distributed when printing by error diffusion, you read a part for an applicable error and make it reflected in the pixel which is going to print this from now on. It was illustrated to drawing 14 by what weighting this error would be distributed to which surrounding pixel to the pixel PP to which its attention is paid. To the pixel PP to which its attention is paid, to several pixels and several pixels which the transportation direction backside of the paper P adjoins, a density error attaches predetermined dignity (1/4, 1/8, 1/16), and is distributed in the scanning direction of the carriage 30.

[0047]Although the ink of two kinds of shades is prepared and the dot of a shade is formed by this example about the cyan ink C and magenta ink, The facilities of an understanding of this invention which have the feature at the point which made concentration of Hierro, Inc. Y high shall be planned, and dot formation shall be performed about cyanogen and magenta in the following explanation based on drawing 12 only in the ink (equivalent to the thick ink C1 and M1) of the usual concentration.

[0048]The same processing as the next is repeated about magenta ink and Hierro, Inc. after processing of a more than about cyan ink. That is, the gradation data about magenta is inputted (Step S130), turning on and off of the dot of magenta is determined with reference to table TM (Step S140), and error calculation about magenta and processing of error diffusion are performed (Step S150). The gradation data about Hierro is inputted (Step S160), turning on and off of the

dot of Hierro is determined with reference to the table TY (Step S170), and error calculation about Hierro and processing of error diffusion are performed (Step S180). Under the present circumstances, compared with the recording rate about cyanogen and magenta, the recording rate of the dot formation by Hierro, Inc. is reduced by the abbreviation 2/3 according to a difference of the table shown in drawing 13.

[0049]As a result of the recording rate of the dot about Hierro being pressed down by about 2/3 to the recording rate of the dot of ink, such as magenta, the dot of Hierro does not fill a print area thoroughly, even when gradation data is the maximum. Drawing 15 is an explanatory view showing the situation of the dot formation in the maximum [gradation / magenta and / of Hierro] (it is 255 with gradation data). In this example, turning on and off of a dot is determined by making the matrix of 3x3 into a unit with the distributed dither method. Drawing 15 (a) shows that the recording rate is 100 [%], when Hierro, Inc. Y1 of concentration is usually used and gradation data is the maximum. On the other hand, in forming a dot by high-concentration Hierro, Inc. Y2 which used by this example, as it shows in drawing 15 (b), even when gradation data is the maximum (255), only six dots of Hierro, Inc. Y2 are not formed. On the other hand, as the dot of the magenta ink M was shown in drawing 15 (c), nine 3x3 will be formed. As a result, when the dot of both ink is formed, as shown in drawing 15 (d), the magenta ink M will be breathed out by the paper about three dots.

[0050]The result mentioned above is produced by having made dye concentration of Hierro, Inc. into 1.5 times to usual Hierro, Inc. Although the gradation number which the dot formed of Hierro, Inc. can express is usual two thirds, since Hierro, Inc. has high brightness, even if a dot is sparsely formed corresponding to the low-concentration field of an original image, most granulation is not sensed from the first. As a result, the advantage that the total of the dot formed per unit area, i.e., the ink quantity breathed out per unit area, can be reduced without causing the problem of deterioration of the image quality by granulation is acquired. Since a maximum (duty restrictions) exists in the total amount of the ink in which the regurgitation is possible for every paper per unit area, the merit which can reduce required ink quantity is large by making concentration of Hierro, Inc. high. For example, if realizable in cyan ink 100[%]+ magenta ink 100[%]+ Hierro, Inc. 60 [%], composite black, Compared with the duty (300 [%]) at the time of using Hierro, Inc. (the maximum recording rate 100 [%]) of the usual concentration, the margin of about 40 [%] will be born to duty restrictions of a paper. Duty restrictions in the example which outputs dark red on the paper of 190 [%]. If it prints conventionally in the cyanogen 10 [%], the magenta 100 [%], and Hierro 100 [%], in order that the sum total may be set to 210 [%] and may exceed duty restrictions, 10% needed to be transposed to black ink and it needed to print with the magenta 90 [%], Hierro 90 [%], and the black 10 [%]. However, when it transposed to such black ink and having been printed, the dot of conspicuous black was sparsely formed most at high concentration into red, granulation got worse, and image quality was deteriorating. In this example, even if it does not use black ink, it dedicates within duty restrictions in the cyanogen 10 [%], the magenta 100 [%], and Hierro 67 [%], and granulation is good and can obtain a high definition output. That is, if the Hierro concentration is raised like this example, using the margin of the duty restrictions obtained by it, each amount of color ink will be optimized and it will become possible to attain further high definition-ization.

[0051]In this example, since the dye concentration of Hierro, Inc. is raised and the required dot number is reduced, the advantage that a margin produces only the reduced dot number to the overprint of each color ink is also acquired. That the 1/3-about part by which dot formation is not carried out about Hierro, Inc. exists although various devices are made about the lap of ink becomes the merit that the flexibility of the dot arrangement in the overprint of such a plural color can be raised. Saying that there is few formation of the dot by Hierro, Inc. is that the

average amount of consumption of Hierro, Inc. at the time of printing a predetermined area is also referred to as few. As a result, the quantity of Hierro, Inc. which should be carried in the ink cartridge 70 can also be reduced. If ink quantity is reduced, the dignity of the cartridge 70 can be reduced and the mechanism in which the cartridge 70 is conveyed can also be simplified. The part which reduced the capacity of Hierro, Inc., and other ink quantity can also be increased. Since the quantity of shading ink can be increased like this example when using the ink of two kinds of shades, the merit is large.

[0052]In the above, with this printer 20, although the example of this invention was described, since the ink of two kinds of shades is used, proper use of the ink of two kinds of shades about magenta and cyanogen is explained briefly. It is judged whether the processing (Step S110) for which it opts about turning on and off of the dot of cyanogen C ink with reference to table TC, and the processing (Step S140) for which it opts about magenta similarly form a dot about the ink of two kinds of shades in detail.

[0053]In both steps, processing which determines turning on and off of a dark dot is performed based on gradation data DS inputted first. The details of the processing which determines turning on and off of this dark dot were shown in the dark dot formation judging process routine of drawing 17. In this manipulation routine, processing which generates the dark level data Dth with reference to the table of drawing 18 based on gradation data DS is performed first (Step S222). Drawing 18 shows the table which sets up into how much the recording rate of light ink and thick ink is made to the gradation data of the original picture. gradation data takes the value to 0-255 about each color -- since the thing is carried out (8 bits of each color), the size of gradation data is expressed like 16 / 256 grades below. When the table of drawing 18 shows the rate of the thick ink in the printed matter obtained eventually, and light ink and a certain gradation data is given, The recording rate of thick ink and the recording rate of light ink are given to a meaning, and turning on and off of the dot by the thick ink or light ink of a pixel to which its attention is paid is not defined. If this relation is explained briefly, in this example, turning on and off of a dark dot will be first judged using this table, and turning on and off of a light dot will be judged with reference to that result. Therefore, the recording rate of a light dot depends on the following reason [being in agreement with the table shown in drawing 18].

[0054]The number of the dark dot formed there and light dots can express the concentration of the picture per unit area. According to drawing 18, the case where concentration is the maximum about the number of the dark dots formed per unit area is considered as a rate over this as the value 255, and this is set to Ks. The number of light dots is similarly set to Us. It will be set to DS=Ksx (evaluation value of a dark dot) / 255+Usx (evaluation value of a light dot) / 255 if it is going to make it equal to gradation data DS of a picture which inputted the concentration of the picture formed at this time. Since it can consider that the evaluation value (thickness of the formed dot) of a dark dot is 255, the table of the light dot shown in drawing 18 will be decided by how many the evaluation value of the table of a dark dot and a light dot is taken. If the data of the point (18 and light dot data are [gradation data] 122 in 95 and dark dot data) that the recording rate of a light dot serves as the maximum, for example is inputted into an upper type in the example shown in drawing 18, A light dot evaluation value is set to Z, it is set to 95=18x255/255+122xZ/255, and a light dot evaluation value is set to 160. This dark dot evaluation value and a light dot evaluation value are the same as what is treated as result value RV with the flow chart of the determination technique of turning on and off of a dark dot and a light dot mentioned later.

[0055]Based on inputted gradation data DS, the dark level data Dth corresponding to the recording rate of the thick ink defined beforehand is obtained by referring to the table of drawing 18 (drawing 18 right-hand side vertical axis). For example, when the inputted gradation data of

cyanogen prints 50/256 of solid fields, the recording rate of the cyan ink C1 which is thick ink is 0%, and dark level data also serves as the value 0. When gradation data prints 95/256 of solid fields, the recording rate of the cyan ink C1 which is thick ink is 7%, and the dark level data Dth serves as the value 18. When gradation data prints 191/256 of solid fields, the recording rate of the cyan ink C1 is 75%, and dark level data serves as the value 191. If turning on and off of a light dot is judged by the technique later mentioned in these cases, the recording rate of the light cyan ink C2 which is light ink will be 36%, 58%, and 0%, respectively.

[0056]Next, it is judged whether the dark level data Dth obtained in this way is larger than threshold Dref1 (Step S224). This threshold Dref1 is a decision value of whether to form the dot by thick ink in the pixel to which its attention was paid, and it can also be simply fixed about [of the maximum of the dark level data Dth] to 1/2. In this example, the threshold matrix of the distributed dither was adopted as setting out of this threshold, especially, about 64x64 global matrix (blue noise matrix) was used, systematic dithering method was applied, and the distributed type matrix was adopted as a threshold. Therefore, threshold Dref1 which defines turning on and off of a dark dot becomes a different value for every pixel to which its attention is paid. A distributed type threshold matrix has the high spatial frequency of the dot determined by the threshold matrix, and a dot says in a field the type by which it is generated scatteringly. Specifically, the Beyer type threshold matrix etc. are known. Since generating of a dark dot will be scatteringly performed if a distributed type dither is adopted, distribution of a shade dot does not incline but image quality improves.

[0057]When the dark dot data Dth are larger than threshold Dref1, it judges that the dark dot of the pixel is made one, and also processing which calculates result value RV is performed (Step S226). Result value RV is a value (dark dot evaluation value) equivalent to the concentration of the pixel, and when a dark dot judges that the dot in ink with high concentration is formed in one, i.e., the pixel, the value (for example, value 255) to which the concentration of the pixel was equivalent is set up. This result value RV may be set up as a function of the dark level data Dth, although a fixed value may be sufficient.

[0058]On the other hand, when the dark level data Dth is the one or less threshold Dref, it judges that a dark dot is not turned off namely, formed, and also processing which assigns the value 0 to result value RV is performed (Step S228). Since the white ground of a paper remains, the part in which the dot in ink with high concentration is not formed makes result value RV the value 0.

[0059]In this way, turning on and off of a dark dot is determined, and after performing processing which calculates result value RV, as shown in drawing 17 below, processing which calculates amendment data DC which added diffusion-errors **Du from the pixel nearby [whose] has been processed is first performed to gradation data DS of the pixel to which its attention is paid (Step S240). This is for processing error diffusion. Then, when it judges whether the dark dot was considered as one (dot formation by the cyan ink C1) (Step S242) and the dark dot is not formed. Processing which determines turning on and off of a dot with low concentration, i.e., the dot in the light cyan ink C2, (it is hereafter called a light dot) is performed (Step S 244 or less processing).

[0060]It is judged whether formation of the dot in the light cyan ink C2 has gradation data DC larger than threshold Dref2 for light dots which applied this error diffusion method and was amended by the view of error diffusion in the example (Step S244). This threshold Dref2 is a decision value of whether to form the dot by light ink with low concentration in the pixel to which its attention was paid, and it was set up by this example as a value changed according to amended data DC.

[0061]If amendment data DC is larger than threshold Dref2, one [a light dot] will be judged and result value RV (light dot evaluation value) will be calculated (Step S246). By this example,

result value RV made the value 122 the reference value, and was taken as the value amended by amendment data DC. On the other hand, when amendment data DC is judged to be the two or less threshold Dref, it judges that a light dot is turned OFF and processing which includes the value 0 in result value RV is performed (Step S248).

[0062]In this way, although record by the light dot and a dark dot will be performed, drawing 19 showed this situation typically about the cyan ink C1 and the light cyan ink C2. The field where the inputted gradation data is low (in an example.) Gradation data in the field of 0 / 256 - 63/256. As shown in drawing 19 (a) and (b), only the dot in the light cyan ink C2 is formed, And the rate of the light dot which exists in a predetermined field increases (drawing 19 (c) thru/or (e)), if gradation data becomes still higher, formation of a light dot will no longer be performed and only a dark dot will be formed, as gradation data becomes high (drawing 19 (f), (g)). If gradation data serves as the maximum, as shown in drawing 19 (h), the recording rate by a dark dot will be 100%.

[0063]In the printer 20 of this example explained above, while employing Hierro, Inc. where dye concentration is higher than usual, Carry the ink cartridge 70 which has cyan ink of two kinds of shades, and magenta ink in the carriage 30, and the gradation of an inputted image in a low field. Since it prints using the low light cyan ink and light magenta ink of dye concentration, the granular feeling in the field where gradation is low is not conspicuous, and the advantage that print quality is very high is acquired. Since concentration of Hierro, Inc. can be made high in the range in which the granular feeling about the dot of Hierro, Inc. is not conspicuous, its about 4 times are possible at dye concentration. At this time, the average discharge quantity of Hierro, Inc. can be reduced substantially.

[0064]It is not limited to Hierro, Inc. and what is necessary is just to raise the concentration of ink with the highest brightness, or ink with the lowest visibility of granulation in the combination of the color of the ink used for printing in the above-mentioned example, although concentration of Hierro, Inc. was made high. Although correction of the bias of the color balance by having raised the dye concentration of Hierro, Inc. was performed by making the rate of the dot formation of Hierro, Inc. low in this example, this bias is correctable also by reducing the path of the dot formed of Hierro, Inc. The size of the dot formed on the paper P is controllable by adjusting the strength (voltage and duration time) etc. of the voltage pulse which carries out a seal of approval to the diameter and piezo-electric element PE of a nozzle for ink discharge. For example, what is necessary is to form the nozzle 66 for Hierro, Inc. of the above-mentioned example as a nozzle for byway dots, and just to form the nozzles 62 and 63 for cyan ink C, the nozzle 64 for magenta ink M, and a logo as a nozzle for major-diameter dots.

[0065]Although the program which controls formation of each color dots was prepared for the printer driver [not the printer 20 but] 96 side of the computer 90 in above-mentioned this example, preparing in the printer 20 is also possible. For example, from the computer 90, when the picture information printed with languages, such as PostScript, is sent, it will have the half tone module 99 etc. in the printer 20 side. The software program which realizes these functions is memorized by the hard disk in the computer 90, etc., when the computer 90 starts it, it is included in an operating system with the gestalt of a printer driver at this example, but. It is also possible for it to be stored in portable storage media (portability type storage), such as a floppy disk and CD-ROM, and to be transmitted to the main memory or the external storage of a computer system from a portable storage medium. It is also possible to consider it as the gestalt which is transmitted to the inside of the printer 20 and is used for it from the computer 90. The device which provides the software program of this can be formed via a communication line, and it can also be considered as the gestalt which transmits and uses the contents of processing of the above-mentioned half tone module for this computer and printer 20 via a communication line.

[0066]In the example mentioned above, when any regurgitation of the ink of a shade carries out the seal of approval of the voltage of specified time width to piezo-electric element PE using piezo-electric element PE, it is carrying out, but it is also easy to adopt other ink discharge methods. As an ink discharge method put in practical use, if it divides roughly, ink particles will be separated from the continuous ink jet, and it will be divided roughly into the method on demand which are a method which carries out the regurgitation, and a method adopted also in the example mentioned above. The micro dot method etc. which use for printing the very small satellite particles produced when major-diameter particles are divided in the former from the jet of the electrification modulation method in which a drop is disunited from the jet of ink by electrification abnormal conditions, and ink are known. These methods are also applicable to the printer of this invention using the ink of two or more kinds of concentration.
[0067]When ink particles are [method on demand] needed by a dot unit, As ink particles are generated and it is shown in drawing 20 (A) - (E) besides the method using the piezo-electric element adopted in the example mentioned above, Heating element HT is provided near the nozzle NZ of ink, the bubble BU is generated by heating ink, and the method etc. which carry out the regurgitation of ink particle IQ with the pressure are known. The ink discharge method of these methods on demand is also applicable to the printer of this invention using several dots from which the ink of two or more kinds of concentration or a path differs. In addition to this, the view referred to as making high concentration of the highest ink of brightness or ink with the lowest visibility of granulation is applicable also to the color printer of electrophotographying systems, such as a color printer of a hot printing method, and laser.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]However, in the case of a printer, it has stopped at tens of microns with 300dpi thru/or about 720 dpi, and particle diameter at print density (resolution), and the distance between the power of expression (on a film, called thousands dpi in resolution) of a film photo is still large. In particular, a dot will be formed sparsely (what is called granulation), and this will stand out in the field where image concentration is low, i.e., the field where the dot density printed is low. In the printer of the type which carries out the regurgitation of the liquefied ink to a paper, the total amount of the ink breathed out per unit area is restricted by possible ink absorption (what is called an ink duty) on a paper. In the printer which uses two or more kinds of ink for color printing, it was also a technical problem to clear this restriction in the low paper of an ink duty. Especially the problem of this ink duty prepares the ink of two kinds of shades about each color ink, and in the low field of gradation, when it prints using ink with low concentration and is going to make granulation not conspicuous, it actualizes it. It is because the total amount of the ink which carries out the regurgitation will increase if it is going to express predetermined gradation using light ink.
[0005]In the printer provided with the head in which the regurgitation is possible for three or more kinds of ink which can express the hue of a prescribed range by being intermingled, an object [without adjusting the concentration of specific ink and falling the grace of the picture recorded] of this invention is to ease restriction of an ink duty etc.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is an outline lineblock diagram of the printer 20 of an example.
[Drawing 2]It is a block diagram showing the composition of the control circuit 40 in the printer 20.
[Drawing 3]It is a perspective view showing the composition of the carriage 30.
[Drawing 4]It is an explanatory view showing arrangement of each color heads 61 thru/or 66 in the printhead 28.
[Drawing 5]It is a perspective view showing the shape of the cartridge 70 for color ink.
[Drawing 6]It is an explanatory view showing the composition for the ink discharge in each color heads 61 thru/or 66.
[Drawing 7]It is an explanatory view showing signs that the ink particles Ip are breathed out by extension of piezo-electric element PE.
[Drawing 8]It is a block diagram in which the situation of processing is illustrated until printing is performed from the picture information which the computer 90 treats.
[Drawing 9]It is an explanatory view showing the ingredient of each color ink.
[Drawing 10]It is a graph which illustrates the relation between the recording rate of each color ink, and brightness.
[Drawing 11]It is an explanatory view showing the hue of each color ink in CIELAB space, and the relation of chroma saturation.
[Drawing 12]It is a flow chart which illustrates the processing in the half tone module 99.
[Drawing 13]It is an explanatory view showing cyanogen, magenta, and the table showing the relation of the input data and the recording rate in Hierro, Inc.
[Drawing 14]It is an explanatory view which illustrates the situation of distribution of the error to the circumference dot in error diffusion.
[Drawing 15]It is an explanatory view showing the situation of formation of the dot by Hierro and magenta ink.
[Drawing 16]It is a flow chart which shows a dark dot formation judging process routine.
[Drawing 17]It is a flow chart which shows a light dot formation judging process routine.
[Drawing 18]It is a graph which illustrates the relation of the recording rate and gradation data based on the light ink and thick ink in this example.
[Drawing 19]It is the explanatory view which illustrated the process of the dot formation by shading ink.
[Drawing 20]It is an explanatory view showing other examples of composition of the discharging mechanism of ink particles.
[Description of Notations]
20 -- Printer
22 -- Paper feed motor
24 -- Carriage motor
26 -- Platen
28 -- Printhead
30 -- Carriage
31 -- Divider plate
32 -- Navigational panel
34 -- Sliding shaft
36 -- Driving belt
38 -- Belt pulley
39 -- Position detection sensor
40 -- Control circuit

41 -- CPU
43 -- ROM
44 -- RAM
50 -- I/F dedicated communication circuit
52 -- Head drive circuit
54 -- Motor drive circuit
56 -- Connector
61-66 -- Head for ink discharge
70 -- Cartridge for color ink
71 -- Introducing pipe
80 -- Ink passage
90 -- Computer
91 -- Video driver
93 -- CRT display
95 -- Application program
96 -- Printer driver
97 -- Rasterizer
98 -- Color correction module
99 -- Half tone module
P -- Paper
PE -- Piezo-electric element
n -- Nozzle

[Translation done.]

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審査請求　未請求　請求項の数18　ＦＤ　（全 18 頁）

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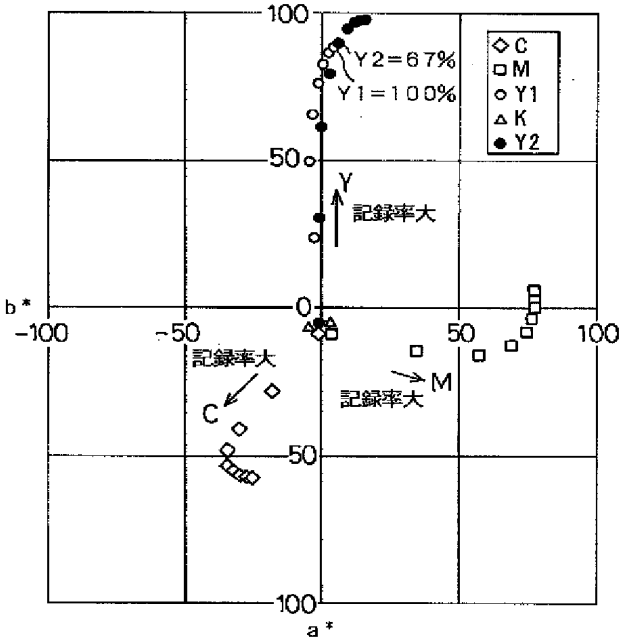
(54)【発明の名称】　印刷装置，印刷方法およびこれに用いるインクカートリッジ

(57)【要約】

【課題】　混在することにより所定範囲の色相を表現可能な３種類以上のインクの吐出量を低減しつつ、粒状感の発生を抑制する。

【解決手段】　入力した各色の階調データから、テーブルＴＣ，ＴＭ，ＴＹを参照して、各色インクの記録率を求め、この記録率に応じてドットを形成する。イエロインクの染料濃度は、色バランスのとれた濃度より高めてあるので、シアンＣ，マゼンタＭの記録率に対して、イエロＹの記録率は低く押さえられている。イエロＹは、明度が高く、階調データが低い領域に対応してまばらにドットが形成されても粒状感は目立たない。イエロインクＹの濃度が高められていることから、印刷に必要な濃度に対してヘッドから吐出されるインク量は低減される。



【特許請求の範囲】
【請求項１】　混在することにより所定範囲の色相を表現可能な３種類以上のインクを被印刷物に記録可能なヘッドを備えた印刷装置であって、
前記各色インクのうち、同じ記録率当たりの明度が最も高いインクと他のインクとの濃度比を、これらのインクの単位面積当たりの記録率を等しくしたときの色バランスが該明度が最も高いインクの側に偏るよう該各色インクを備え、
該偏りを是正する比率まで、該明度が最も高いインクの記録量を補正する補正手段を有する印刷装置。
【請求項２】　混在することにより所定範囲の色相を表現可能な３種類以上のインクを被印刷物に記録可能なヘッドを備えた印刷装置であって、
前記各色インクのうち、同じ記録率とした場合の粒状化の視認性が最も低いインクと他のインクとの濃度比を、これらのインクの単位面積当たりの記録率を等しくしたときの色バランスが該粒状化の視認性が最も低いインクの側に偏るよう該各色インクを備え、
該偏りを是正する比率まで、該粒状化の視認性が最も低いインクの記録量を補正する補正手段を有する印刷装置。
【請求項３】　前記３種類以上のインクが、イエロ，マゼンタ，シアンであり、前記明度が最も高いインクまたは粒状化の視認性が最も低いインクがイエロである請求項１または請求項２記載の印刷装置。
【請求項４】　前記明度が最も高いインクまたは粒状化の視認性が最も低いインクの染料濃度が、前記３種類以上のインクの単位面積当たりの記録率が等しい場合にバランスする濃度より１．１ないし４倍の範囲で高くされた請求項１または請求項２記載の印刷装置。
【請求項５】　前記明度が最も高いインクまたは粒状化の視認性が最も低いインクの記録量の補正が、該インクによるドットの形成の割合を低減するものである請求項１または請求項２記載の印刷装置。
【請求項６】　前記明度が最も高いインクまたは粒状化の視認性が最も低いインクの記録量の補正が、該インクによるドットの径を低減するものである請求項１または請求項２記載の印刷装置。
【請求項７】　請求項１または請求項２記載の印刷装置であって、
前記被印刷物に記録される前記３種類以上の各インクが、染料または顔料を溶剤に溶融または分散した溶液として提供され、
前記ヘッドは、該染料または顔料を含有する溶液を、該被印刷物に吐出するヘッドであり、
前記補正手段は、インクの吐出量の補正を行なう手段である印刷装置。
【請求項８】　請求項７記載の印刷装置であって、
前記溶液として提供される３種類以上のインクのうち、吐出量の補正がなされるインク以外のインクについては、濃淡２種類以上の濃度のインクを備え、
前記ヘッドは、該濃淡２種類以上の濃度のインクと共に、前記前記明度が最も高いインクまたは粒状化の視認性が最も低いインクを吐出可能である印刷装置。
【請求項９】　前記濃淡インクはマゼンタおよびシアンの各色インクについて備えられ、各色の低濃度インクの染料濃度は、高濃度インクの染料濃度の略１／４である請求項８記載の印刷装置。
【請求項１０】　前記ヘッドは、インク通路に設けられた電歪素子への電圧の印加によりインクに付与される圧力によってインク粒子を吐出する機構を備えた請求項７記載の印刷装置。
【請求項１１】　前記ヘッドは、インク通路に設けられた発熱体への通電により発生する気泡により該インク通路のインクに付与される圧力によってインク粒子を吐出する機構を備えた請求項７記載の印刷装置。
【請求項１２】　ディザ法により前記各色インクによるドットの有無を決定する手段を備えた請求項１または請求項２記載の印刷装置。
【請求項１３】　前記ディザ法の閾値マトリックスが分散型の閾値マトリックスである請求項１２記載の印刷装置。
【請求項１４】　混在することにより所定範囲の色相を表現可能な３種類以上のインクを記録可能なヘッドを備え、印刷しようとする画像の階調信号に基づいて該３種類以上のインクのドットの分布を制御して多階調の画像を印刷する方法であって、
前記各色インクのうち、同じ記録率当たりの明度が最も高いインクと他のインクとの濃度比を、これらのインクの単位面積当たりの記録率を等しくしたときの色バランスが該明度が最も高いインクの側に偏るよう設定し、
該偏りを是正する比率まで、該明度が最も高いインクの記録量を補正する印刷方法。
【請求項１５】　混在することにより所定範囲の色相を表現可能な３種類以上のインクを記録可能なヘッドを備え、印刷しようとする画像の階調信号に基づいて該３種類以上のインクのドットの分布を制御して多階調の画像を印刷する方法であって、
前記各色インクのうち、同じ記録率とした場合の粒状化の視認性が最も低いインクと他のインクとの濃度比を、これらのインクの単位面積当たりの記録率を等しくしたときの色バランスが該粒状化の視認性が最も低いインクの側に偏るよう設定し、
該偏りを是正する比率まで、該粒状化の視認性が最も低いインクの記録量を補正する印刷方法。
【請求項１６】　請求項１または請求項２記載の印刷装置に装着して用いられるインクカートリッジであって、
混在することにより所定範囲の色相を表現可能な３種類以上のインクを収納し、

該３種類以上のインクのうち、前記明度が最も高いインクまたは粒状化の視認性が最も低いインクについては、その染料濃度を、他のインクと比べて、単位面積当たりの記録率が等しい場合にバランスする濃度より高く設定すると共に、その収容量を、他のインクの収容量と同等または少ない容量としたインクカートリッジ。

【請求項１７】　請求項８記載の印刷装置に装着して用いられるインクカートリッジであって、
前記明度が最も高いインクまたは粒状化の視認性が最も低いインクの容量を、前記濃淡２種類以上用意されたインクの各収容量と同等もしくは多い容量としたインクカートリッジ。

【請求項１８】　請求項１４または請求項１５記載の印刷方法に用いられるインクカートリッジであって、
混在することにより所定範囲の色相を表現可能な３種類以上のインクを収納し、
該３種類以上のインクのうち、前記明度が最も高いインクまたは粒状化の視認性が最も低いインクについては、その染料濃度を、他のインクと比べて、単位面積当たりの記録率が等しい場合にバランスする濃度より高く設定すると共に、その収容量を、他のインクの収容量と同等または少ない容量としたインクカートリッジ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、混在することにより所定範囲の色相を表現可能な３種類以上のインクを記録可能なヘッドを備え、このヘッドにより被印刷物に記録されるインクにより多階調の画像を記録可能な印刷装置，印刷方法およびこれに用いるインクカートリッジに関する。

【０００２】

【従来の技術】近年、コンピュータの出力装置として、数色のインクをヘッドにより被印刷物に記録するタイプのカラープリンタが広く普及し、コンピュータ等が処理した画像を多色多階調で印刷するのに広く用いられている。被印刷物にインクを記録する方法としては、インクリボン上のインクを溶融して用紙に転写する熱転写方式、カラーインクの溶液を用紙に向けて吐出するインクジェット方式、レーザにより感光体上に潜像を形成しカラートナーを転写する電子写真方式など、様々な手法が知られている。いずれの場合にも、数種類の色のインクを混在されることにより所定の色相の範囲の色を再現するものであり、フルカラーの印刷を行なう場合には、通常シアン，マゼンタ，イエロー（ＣＭＹ）の三色のインクを用いる。

【０００３】こうした複数種類のインクにより多色の画像を印刷する場合、多階調の画像を形成しようとするにはいくつかの方法が考えられる。一つは、従来のプリンタで採用されている手法であり、一度に吐出するインクにより用紙上に形成されるドットの大きさを一定として、印刷される画像の階調を、ドットの密度（単位面積当たりの出現頻度）により表現するものである。もう一つの方法は、用紙上に形成するドット径を調整して、単位面積当たりの濃度を可変するものである。最近では、インク粒子を形成するヘッドの微細加工が進み、所定長さ当たりに形成できるドットの密度やドット径の可変範囲などは、年々向上している。

【０００４】

【発明が解決しようとする課題】しかしながら、プリンタの場合には、印字密度（解像度）で３００ｄｐｉないし７２０ｄｐｉ程度、粒径で数十ミクロンに留まっており、銀塩写真の表現力（フィルム上では解像度で数千ｄｐｉと言われる）との間の隔たりは未だ大きい。特に、画像濃度の低い領域、即ち印刷されるドット密度の低い領域では、ドットがまばらに形成され（いわゆる粒状化）、これが目に付いてしまう。また、液状のインクを用紙に吐出するタイプの印刷装置では、単位面積当たりに吐出されるインクの総量は、用紙上で可能なインク吸収量（いわゆるインクデューティ）により制限される。カラー印刷のために複数種類のインクを用いる印刷装置では、インクデューティの低い用紙では、この制限をクリアすることも課題であった。このインクデューティの問題は、特に、各色インクについて濃淡２種類のインクを用意し、階調の低い領域では濃度の低いインクを用いて印刷を行ない、粒状化を目立たないようにしようとした場合、顕在化する。淡インクを用いて所定の階調を表現しようとすると、吐出するインクの総量が増加してしまうからである。

【０００５】本発明は、混在することにより所定範囲の色相を表現可能な３種類以上のインクを吐出可能なヘッドを備えた印刷装置において、特定のインクの濃度を調整し、記録される画像の品位を低下することなく、インクデューティなどの制限を緩和することを目的とする。

【０００６】

【課題を解決するための手段およびその作用・効果】かかる目的を達成するため、本願発明は、以下の構成を採用した。まず、本発明の第１の印刷装置は、混在することにより所定範囲の色相を表現可能な３種類以上のインクを被印刷物に記録可能なヘッドを備えた印刷装置において、前記各色インクのうち、同じ記録率当たりの明度が最も高いインクと他のインクとの濃度比を、これらのインクの単位面積当たりの記録率を等しくしたときの色バランスが該明度が最も高いインクの側に偏るよう該各色インクを備え、該偏りを是正する比率まで、該明度が最も高いインクの記録量を補正する補正手段を有することを要旨としている。

【０００７】また、本発明の第１の印刷方法は、混在することにより所定範囲の色相を表現可能な３種類以上のインクを被印刷物に記録可能なヘッドを備え、印刷しようとする画像の階調信号に基づいて該３種類以上のイン

クのドットの分布を制御して多階調の画像を印刷する方法であって、前記各色インクのうち、同じ記録率当たりの明度が最も高いインクと他のインクとの濃度比を、これらのインクの単位面積当たりの記録率を等しくしたときの色バランスが該明度が最も高いインクの側に偏るよう設定し、該偏りを是正する比率まで、該明度が最も高いインクの記録量を補正することを要旨としている。

【０００８】この印刷装置および印刷方法は、混在することにより所定範囲の色相を表現可能な３種類以上のインクを記録可能なヘッドを備えており、これらのインクによるドットを所定の割合で形成することにより、様々な色相、明度（濃度）の画像を形成する。その際、本発明の印刷装置では、各色インクの単位面積当たりの記録率を等しくしたときの色バランスをわざと崩し、同じ記録率当たりの明度が最も高いインクの側に色バランスが偏るようにしている。従って、単位面積当たりの記録率を同じにすると、色バランスは、明度が最も高いインクの側に偏るから、補正手段により、この偏りを是正する比率まで、明度が最も高いインクの記録量を補正する。この結果、色バランスは正常になり、かつ明度が最も高く、低濃度での粒状化の影響の少ないインクの記録量が低減されるので、形成される画像の品質を損なうことなく、記録される全インクの総量を低減することができる。

【０００９】また、本発明の第２の印刷装置は、混在することにより所定範囲の色相を表現可能な３種類以上のインクを被印刷物に記録可能なヘッドを備えた印刷装置において、前記各色インクのうち、同じ記録率とした場合の粒状化の視認性が最も低いインクと他のインクとの濃度比を、これらのインクの単位面積当たりの記録率を等しくしたときの色バランスが該粒状化の視認性が最も低いインクの側に偏るよう該各色インクを備え、該偏りを是正する比率まで、該粒状化の視認性が最も低いインクの記録量を補正する補正手段を有することを要旨としている。

【００１０】また、本発明の第２の印刷方法は、混在することにより所定範囲の色相を表現可能な３種類以上のインクを被印刷物に記録可能なヘッドを備え、印刷しようとする画像の階調信号に基づいて該３種類以上のインクのドットの分布を制御して多階調の画像を印刷する方法であって、前記各色インクのうち、同じ記録率とした場合の粒状化の視認性が最も低いインクと他のインクとの濃度比を、これらのインクの単位面積当たりの記録率を等しくしたときの色バランスが該粒状化の視認性が最も低いインクの側に偏るよう設定し、該偏りを是正する比率まで、該粒状化の視認性が最も低いインクの記録量を補正することを要旨としている。

【００１１】この印刷装置および印刷方法では、第１の印刷装置および第１の印刷方法同様、混在することにより所定範囲の色相を表現可能な３種類以上のインクを記録可能なヘッドを備えており、これらのインクによるドットを所定の割合で形成することにより、様々な色相、明度（濃度）の画像を形成する。その際、第２発明の印刷装置では、各色インクの単位面積当たりの記録率を等しくしたときの色バランスをわざと崩し、同じ記録率とした場合の粒状化の視認性が最も低いインクの側に色バランスが偏るようにしている。従って、単位面積当たりの記録率を同じにすると、色バランスは、粒状化の視認性が最も低いインクの側に偏るから、補正手段により、この偏りを是正する比率まで、粒状化の視認性が最も低いインクの記録量を補正する。この結果、色バランスは正常になり、かつ粒状化の視認性が低いインクの記録量が低減されるので、形成される画像の品質を損なうことなく、記録される全インクの総量を低減することができる。

【００１２】こうした印刷装置における３種類以上のインクとしては、いわゆる三原色としてのイエロ，マゼンタ，シアンのインクを採用することが実用的であり、このうち明度が最も高いインクまたは粒状化の視認性が最も低いインクとしてはイエロを選択することが実用的である。もとより、他の色の組み合わせの場合には、それらの色の中で、最も明度の高いインクまたは最も粒状化の視認性の低いインクを選択すればよい。

【００１３】各色インクの組み合わせの色バランスを偏らせる手法は、様々なアプローチが考えられるが、その一つとしては、明度が最も高いインクまたは粒状化の視認性が最も低いインクの染料濃度を、３種類以上のインクの単位面積当たりの記録率が等しい場合にバランスする濃度より１．１ないし４倍の範囲で高くすることである。濃度が１．１倍未満では、濃度を高めたことによる効果が期待できず、４倍より高くすると、粒状性が感じられてしまう。染料濃度の調整は容易なので、簡単に色バランスを所望の偏りにすることができる。

【００１４】この場合には、明度が最も高いインクまたは粒状化の視認性が最も低いインクの記録量の補正は、該インクによるドットの形成の割合を低減することにより達成することができる。他の補正の手法としては、このインクによるドットの径を低減することが考えられる。

【００１５】なお、予め各色インクの組み合わせの色バランスを偏らせる手法の一つとして、明度が最も高いインクまたは粒状化の視認性が最も低いインクのドット径を、他のインクのドット径よりあらかじめ大きくしておくことも考えられる。この場合の補正手段は、ドット形成の割合を低減することにより補正を行なうことができる。

【００１６】３種類以上のインクを被印刷物に記録する方式としては、従来から知られた各方式が適用可能であり、例えば、３種類以上の各インクを、染料または顔料を溶剤に溶融または分散した溶液として提供するものと

し、ヘッドを、この染料または顔料を含有する溶液を、該被印刷物に吐出するヘッドとし、補正手段を、インクの吐出量の補正を行なう手段とすることができる。溶液状のインクを吐出する手法は、微細なドットを比較的高速に形成することができ、好適である。

【００１７】こうした溶液状のインクを用いる印刷装置において、３種類以上のインクのうち、吐出量の補正がなされるインク以外のインクについては、濃淡２種類以上の濃度のインクを備えるものとし、前記ヘッドを、該濃淡２種類以上の濃度のインクと共に、前記前記明度が最も高いインクまたは粒状化の視認性が最も低いインクを吐出可能とすることもできる。すなわち、粒状化の視認性がある程度高いインクについては、濃度の低い淡インクを用意し、濃度の低い領域の粒状化を防止するのである。

【００１８】かかる濃淡インクとしては、色の組み合わせが、イエロ，マゼンタおよびシアンである場合、マゼンタ，シアンについて濃淡２種類以上のインクを備え、各色の低濃度インクの染料濃度を、高濃度インクの染料濃度の略１／４とすることも、濃淡インクの混在箇所の濃度変化の自然さなどの点から好適である。

【００１９】各色のドットの形成の手法は、様々な手法が許容されるが、たとえばディザ法により前記各色インクによるドットの有無を決定するものとすることができる。こうしたディザ法を採用する場合には、ドットのオン・オフを定める閾値マトリックスは分散型の閾値マトリックスとすることができる。分散型の閾値マトリックスを使用すると、ドット分布が分散され、粒状化を感じさせ難いドット形成という点から有利である。

【００２０】こうした印刷装置におけるドット形成のメカニズムは、様々なものが知られているが、例えば、インク通路に設けられた電歪素子への電圧の印加によりインクに付与される圧力によってインク粒子を吐出する機構をヘッドに備えるものとすることができる。あるいは、インク通路に設けられた発熱体への通電により発生する気泡により該インク通路のインクに付与される圧力によってインク粒子を吐出する機構を備えた構成をとることもできる。

【００２１】また、本発明のインクカートリッジは、上述した印刷装置に装着して用いられるもの、または上述した印刷方法に用いられるものであって、混在することにより所定範囲の色相を表現可能な３種類以上のインクを収納し、該３種類以上のインクのうち、前記明度が最も高いインクまたは粒状化の視認性が最も低いインクについては、その染料濃度を、他のインクと比べて、単位面積当たりの記録率が等しい場合にバランスする濃度より高く設定すると共に、その収容量を、他のインクの収容量と同等または少ない容量としたことを要旨としている。

【００２２】上述した印刷装置および印刷方法では、同じ記録率当たりの明度が最も高いインクまたは粒状化の視認性が最も低いインクの濃度が高められており、その体積的な使用量は低減される。したがって、同じ記録率当たりの明度が最も高いインクまたは粒状化の視認性が最も低いインクの収容量を、他のインクと同等または少ない容量とすることにより、各色インクを使い切るまでの期間を同程度にすることができる。

【００２３】また、明度が最も高いインクまたは粒状化の視認性が最も低いインク以外のインクを、濃淡２種類以上用意する場合には、濃淡各インク自体の使用量は少なくなるので、明度が最も高いインクまたは粒状化の視認性が最も低いインクの容量を、これらの濃淡各色のインク容量より多くしたインクカートリッジも有用である。

【００２４】

【発明の他の態様】この発明は、以下のような他の態様も含んでいる。第１の態様は、印刷装置のいくつかの手段を、印刷装置の筐体内部ではなく、印刷しようとする画像を出力する装置の側に置く構成である。補正手段等は、ディスクリートな回路によっても実現可能であるが、ＣＰＵを中心とした算術論理演算回路におけるソフトウェアによっても実現可能である。後者の場合には、印刷しようとする画像を出力する側、例えばコンピュータ側にドットの生成に関する処理まで行なわせ、印刷装置の筐体内には、生成されたドットを、ヘッドからのインクの吐出を制御して、用紙上などに形成する機構のみを収納する形態も考えることができる。

【００２５】本発明の第２の態様は、コンピュータシステムにロードされて実行されるソフトウェアを記録した携帯型記憶媒体としての形態であり、上記の補正手段など処理を行なう手段の少なくとも一部を、ＣＰＵを中心とした算術論理演算回路（ハードウェア）とその上で実行されるソフトウェアプログラムとにより実現するものとし、そのソフトウェアプログラムの少なくとも一部を、この携帯型記憶媒体に格納したものである。

【００２６】第３の形態は、上記のソフトウェアプログラムを通信回線を介して供給する供給装置としての形態である。

【００２７】更に、第４の形態として、上述した印刷装置に用いられるインクカートリッジの発明がある。例えば、本発明の印刷装置が、複数の色インクを用いてカラー印刷を行なう場合、３種類以上のカラーインクを、黒色インクとは別体の容器に収納してなるインクカートリッジを考えることができる。このインクカートリッジは、黒色のインクとは別の容器に収納されていることから、その交換の時期が、通常の文字を中心とした印刷に用いられる黒色インク堪能の消尽とその交換時期に影響されることがない。

【００２８】

【発明の実施の形態】次に、本発明の実施の形態を実施

例に基づき説明する。図１は、この発明の一実施例であるプリンタ２０の概略構成図である。図示するように、このプリンタ２０は、紙送りモータ２２によって用紙Ｐを搬送する機構と、キャリッジモータ２４によってキャリッジ３０をプラテン２６の軸方向に往復動させる機構と、キャリッジ３０に搭載された印字ヘッド２８を駆動してインクの吐出およびドット形成を制御する機構と、これらの紙送りモータ２２，キャリッジモータ２４，印字ヘッド２８および操作パネル３２との信号のやり取りを司る制御回路４０とから構成されている。

【００２９】用紙Ｐを搬送する機構は、紙送りモータ２２の回転をプラテン２６のみならず、図示しない用紙搬送ローラに伝達するギヤトレインを備える（図示省略）。また、キャリッジ３０を往復動させる機構は、プラテン２６の軸と並行に架設されキャリッジ３０を摺動可能に保持する摺動軸３４と、キャリッジモータ２４との間に無端の駆動ベルト３６を張設するプーリ３８と、キャリッジ３０の原点位置を検出する位置検出センサ３９等から構成されている。

【００３０】制御回路４０を中心にこのプリンタ２０の構成を示したのが、図２である。図示するように、この制御回路４０は、周知のＣＰＵ４１，プログラムなどを記憶したＰ－ＲＯＭ４３，ＲＡＭ４４，文字のドットマトリクスを記憶したキャラクタジェネレータ（ＣＧ）４５などを中心とする算術論理演算回路として構成されており、この他、外部のモータ等とのインタフェースを専用に行なうＩ／Ｆ専用回路５０、このＩ／Ｆ専用回路５０に接続されヘッド２８を駆動するヘッド駆動回路５２、同じく紙送りモータ２２およびキャリッジモータ２４を駆動するモータ駆動回路５４を備える。また、Ｉ／Ｆ専用回路５０は、パラレルインタフェース回路を内蔵しており、コネクタ５６を介してコンピュータに接続されて、コンピュータが出力する印刷用の信号を受け取ることができる。コンピュータからの画像信号の出力については後述する。

【００３１】次にキャリッジ３０の具体的な構成と、キャリッジ３０に搭載された印字ヘッド２８によるインクの吐出原理について説明する。図３は、キャリッジ３０の形状を示す斜視図である。また、図４は、キャリッジ３０の下部に配列された印字ヘッド２８における各色インクを吐出するノズル部分を示す平面図である。図３に示すように、キャリッジ３０は、略Ｌ字形状をしており、図示しない黒インク用カートリッジとカラーインク用カートリッジ７０（図５参照）とを搭載可能であって、両カートリッジを装着可能に仕切る仕切板３１を備える。キャリッジ３０の下部の印字ヘッド２８には計６個のインク吐出用ヘッド６１ないし６６が形成されており、キャリッジ３０の底部には、この各色用ヘッドにインクタンクからのインクを導く導入管７１ないし７６が立設されている。キャリッジ３０に黒インク用のカートリッジおよびカラーインク用カートリッジ７０を上方から装着すると、各カートリッジに設けられた接続孔に導入管７１ないし７６が挿入される。

【００３２】インクが吐出される機構を簡単に説明する。図６に示すように、インク用カートリッジ７０がキャリッジ３０に装着されると、毛細管現象を利用してインク用カートリッジ内のインクが導入管７１ないし７６を介して吸い出され、キャリッジ３０下部に設けられた印字ヘッド２８の各色ヘッド６１ないし６６に導かれる。なお、初めてインクカートリッジが装着されたときには、専用のポンプによりインクを各色ヘッド６１ないし６６に吸引する動作が行なわれるが、本実施例では吸引のためのポンプ、吸引時に印字ヘッド２８を覆うキャップ等の構成については図示および説明を省略する。

【００３３】各色ヘッド６１ないし６６には、図４および図６に示したように、各色毎に３２個のノズルｎが設けられており、各ノズル毎に電歪素子の一つであって応答性に優れたピエゾ素子ＰＥが配置されている。ピエゾ素子ＰＥとノズルｎとの構造を詳細に示したのが、図７である。図示するように、ピエゾ素子ＰＥは、ノズルｎまでインクを導くインク通路８０に接する位置に設置されている。ピエゾ素子ＰＥは、周知のように、電圧の印加により結晶構造が歪み、極めて高速に電気－機械エネルギの変換を行なう素子である。本実施例では、ピエゾ素子ＰＥの両端に設けられた電極間に所定時間幅の電圧を印加することにより、図７下段に示すように、ピエゾ素子ＰＥが電圧の印加時間だけ伸張し、インク通路８０の一側壁を変形させる。この結果、インク通路８０の体積は、ピエゾ素子ＰＥの伸張に応じて収縮し、この収縮分に相当するインクが、粒子Ｉｐとなって、ノズルｎの先端から高速に吐出される。このインク粒子Ｉｐがプラテン２６に装着された用紙Ｐに染み込むことにより、印刷が行なわれることになる。

【００３４】印字ヘッド２８における各色ヘッド６１ないし６６の配列は、上述したピエゾ素子ＰＥを配置する関係上、図４に示したように、２つのヘッドを一組として、３組に分けて配設されている。黒インク用カートリッジに近接した側の端に黒インク用のヘッド６１が配設されており、その隣がシアン用のインクヘッド６２である。また、この組に隣接するのが、シアン用インクヘッド６２に供給されるシアンインクより濃度の低いインク（以下、ライトシアンインクと呼ぶ）用のヘッド６３とマゼンタ用のインクヘッド６４である。更にその隣の組には、通常のマゼンタインクより濃度の低いインク（以下、ライトマゼンタインクと呼ぶ）用のヘッド６５と、イエロ用のヘッド６６とが配置されている。各インクの組成および濃度については後述する。

【００３５】以上説明したハードウェア構成を有する本実施例のプリンタ２０は、紙送りモータ２２によりプラテン２６その他のローラを回転して用紙Ｐを搬送しつ

つ、キャリッジ３０をキャリッジモータ２４により往復動させ、同時に印字ヘッド２８の各色ヘッド６１ないし６６のピエゾ素子ＰＥを駆動して、各色インクの吐出を行ない、用紙Ｐ上に多色の画像を形成する。なお、プリンタ２０は、図８に示すように、コンピュータ９０などの画像形成装置からコネクタ５６を介して受け取った信号に基づいて、多色の画像を形成する。この例では、コンピュータ９０内部で動作しているアプリケーションプログラムは、画像の処理を行ないつつビデオドライバ９１を介してＣＲＴディスプレイ９３に画像を表示している。このアプリケーションプログラム９５が、印刷命令を発行すると、コンピュータ９０のプリンタドライバ９６が、画像情報をアプリケーションプログラムから受け取り、これをプリンタ２０が印字可能な信号に変換している。図８に示した例では、プリンタドライバ９６の内部には、アプリケーションプログラム９５が扱っている画像情報をドット単位の色情報に変換するラスタライザ９７、ドット単位の色情報に変換された画像情報（階調データ）に対して画像出力装置（ここではプリンタ２０）の発色の特性に応じた色補正を行なう色補正モジュール９８、色補正された後の画像情報からドット単位でのインクの有無によりある面積での濃度を表現するいわゆるハーフトーンの画像情報を生成するハーフトーンモジュール９９が備えられている。これらの各モジュールの動作は、周知のものなので、説明は原則として省略し、ハーフトーンモジュール９９の内容については、後述する。

【００３６】以上説明したように、本実施例のプリンタ２０は、その印字ヘッド２８に、各色インクを吐出可能なヘッドを備える。このヘッドにより吐出されるイエロインクＹとブラックインクＫは、図９にその成分を示したように、染料としてダイレクトイエロ８６とフードブラック２とを用い、染料の割合を、それぞれ２．７重量パーセント、４．８重量パーセントとしたものである。また、印字ヘッド２８には、このイエロおよびブラックを含むいわゆるＣＭＹＫの４色のインク以外に、ライトシアンインクとライトマゼンタインク用のヘッド６３，６５が設けられている。これらのライトシアンインクおよびライトマゼンタインクは、図９に示したように、通常のシアンインクおよびマゼンタインクの染料濃度を低くしたものである。

【００３７】図示するように、通常濃度のシアンインク（図９中Ｃ１で示す）は、染料であるダイレクトブルー９９を３．６重量パーセント、ジエチレングリコール３０重量パーセント、サーフィノール４６５を１重量パーセント、水６５．４重量パーセントとしたものであるのに対して、ライトシアンインク（図９中Ｃ２で示す）、染料であるダイレクトブルー９９を、シアンインクＣ１の１／４である０．９重量パーセントとし、粘度調整のためにジエチレングリコールを３５重量パーセント、水を６３．１重量パーセントに変更したものである。また、通常濃度のマゼンタインク（図９中Ｍ１で示す）は、染料であるアシッドレッド２８９を２．８重量パーセント、ジエチレングリコール２０重量パーセント、サーフィノール４６５を１重量パーセント、水７９重量パーセントとしたものであるのに対して、ライトマゼンタインク（図９中Ｍ２で示す）は、染料であるアシッドレッドを、マゼンタインクＭ１の１／４である０．７重量パーセント、ジエチレングリコール２５重量パーセント、水７４重量パーセントに変更したものである。いずれのインクも、粘度がおよそ３［ｍＰａ・ｓ］程度に調整されている。本実施例では、各色インクの粘度の他、表面張力も同一に調整しているので、各色ヘッド毎のピエゾ素子ＰＥの制御を、ドットを形成するインクに拠らず同一にすることができる。

【００３８】これらのインクのうち、ブラックを除くカラーインクＣ１，Ｃ２，Ｍ１，Ｍ２，Ｙは、図５に示したインクカートリッジ７０内に収納されており、その容量は、本実施例では、イエロインクが他のインク（Ｃ１，Ｃ２，Ｍ１，Ｍ２）より多いものとしてある。シアンとマゼンタについては、濃淡２種類のインクが収容されているので、濃淡の両者を加えた量よりはイエロインクの容量は、相対的には少ない容量とされている。なお、イエロの容量は、他の色のインクの総量と等しい容量としても良いし、また濃淡の各インクと等しい容量としても良い。

【００３９】これらの各色インクの明度を測定したものを図１０に示した。図１０の横軸はプリンタの記録解像度に対する記録率であり、ノズルｎから吐出したインク粒子Ｉｐにより白色の用紙Ｐにドットを記録した割合を示している。即ち、記録率１００とは、用紙Ｐの全面がインク粒子Ｉｐにより覆われた状態を示している。本実施例では、従来のイエロインクＹ１に対して、染料濃度が高いイエロインクＹ２を採用しているので、まずこの点について説明する。図１０に示したように、イエロインクＹは、三原色ＣＭＹの中では、最も明度が高く、記録率を１００パーセントにしても、明度Ｌ＊は、８０パーセントを超えている。なお、ここで言う明度Ｌ＊とは、ＣＩＥ１９７６Ｌ＊ａ＊ｂ＊色空間（ＣＩＥＬＡＢ空間）における明度である。

【００４０】図１０において、「●」で示したのが、通常の濃度のイエロインク（○）に対して、染料濃度を１．５倍としたイエロインクＹ２の記録率と明度との関係である。図示するように、染料濃度を１．５倍にしたことにより、明度もこれに比例して低下しており、通常濃度のイエロインクＹ１の記録率１００パーセントの明度と等しくなるのが、記録率約６７パーセントの点である。

【００４１】以上、本実施例で採用した各色インクについて、その記録率と明度Ｌ＊との関係について説明した

が、次に記録率と色相および彩度との関係について説明する。図１１は、紙に、本実施例のイエロ，マゼンタ，シアンの三色のインクで印刷を行なった場合であって、各色の記録率を可変した場合の色相と彩度を、ＣＩＥ１９７６Ｌ＊ａ＊ｂ＊色空間（ＣＩＥＬＡＢ空間）のうちａ＊ｂ＊について表わしたものである。ＣＩＥＬＡＢ空間では、一般に、（０，０）を原点として、横軸からの角度が色相を、原点からの距離が彩度を表わしているとみなすことができる。図１１では、通常濃度のＣＭＹ（各々「◇」「□」「○」により表わす）インクひとつひとつについて、その記録率を１０パーセントずつ高くしてゆく場合の色相と彩度の変化を読みとることができる。

【００４２】これに対して、染料の濃度を従来のインクより１．５倍に調整された本実施例のイエロインク（図１１では「●」で示す）は、濃度を１０パーセントずつ高めると、彩度（鮮やかさ）の変化が従来の濃度のインクより大きく、記録率６６パーセントで従来のインクの記録率１００パーセントと一致してしまうことが分かる。当然ドット数の制御範囲は、狭くなる。仮に１０×１０のマトリックスを考えるとすると、従来の濃度のインクでは0から１００個までのドットを制御できるのに対して、濃度１．５倍のイエロインクでは、0から６６個までのドットを制御することになる。

【００４３】通常の濃度の三色インクを各々等しい記録率で記録した場合には、グレーに感じられることになるが、本実施例のイエロインクＹ２を用いた場合には、その記録率をシアンやマゼンタインクの記録率と等しくすると、色相はグレーからイエロの側に偏っていることになる。

【００４４】なお、本実施例では、シアンインクＣとマゼンタインクＭについては、濃淡２種類のインクを採用しているが、これらのインクの明度は次の関係にある。シアンインクＣ１に対してライトシアンインクＣ２は、染料の濃度が重量パーセントで約１／４としており、このときの両インクの明度は、ライトシアンインクＣ２の記録率が１００パーセントの場合の明度が、シアンインクＣ１の記録率が約３５パーセントの場合の明度と等しくなっている。この関係は、マゼンタインクＭ１，ライトマゼンタインクＭ２においても同様である。濃度の異なるインクが同一明度となる記録率の割合は、両インクを混在して印刷した場合の混色の美しさの点から定めたものであるが、実用上は、２０ないし５０パーセントの範囲に調整することが望ましい。この関係を、両インクにおける染料の重量パーセントの割合で表現すると、濃度の高いインク（シアンインクＣ１およびマゼンタインクＭ１）における染料の重量パーセントに対して、濃度の低いインク（ライトシアンインクＣ２およびライトマゼンタインクＭ２）における染料の重量パーセントの関係を、後者が前者の約１／５ないし１／３程度に調整することとほぼ等価である。

【００４５】次に、プリンタドライバ９６のハーフトーンモジュール９９内の処理に沿って、本実施例のプリンタ２０における各色インクのドット形成の様子を説明する。本実施例のプリンタ２０では、濃淡インクを用いて印刷を行なっており、シアンとマゼンタインクについては、濃度の高いインクによるドット（濃ドット）形成と濃度の低いインクによるドット（淡ドット）形成の処理が必要になるが、まず以下では、濃度の高いイエロインク、通常濃度のシアンインクおよびマゼンタインクの各色によるドット形成について説明し、付加的に濃淡インクによるドット形成について説明する。図１２は、ＣＭＹの各色についてのハーフトーンモジュール９９の処理の概要を示すフローチャートである。図示するように、このハーフトーン処理では、基本的に、同じ処理がＣＭＹの各色について繰り返される。

【００４６】まず、図８に示した色補正モジュール９８によりＣＹＭの各色の階調データに変換されたデータのうち、シアンインクＣについての階調データを入力する処理を行なう（ステップＳ１００）。階調データは、８ビットにより表現されているので、０ないし２５５の値を取る。次に、この階調データに基づいて、記録率を決定するテーブルＴＣを参照し、シアンインクのドットについてのオンオフを決定する処理を行なう（ステップＳ１１０）。各色インクについてのテーブルの一例を、図１３に示す。ある色のインクについてのドットのオン・オフの決定は、様々な手法、例えば誤差拡散の手法や組織的ディザ法を採用することができる。本実施例では、誤差拡散の考え方を採用した。したがって、着目している画素のシアン濃度に基づいてドットのオン・オフを決定した後、誤差計算と誤差拡散の処理を行なう（ステップＳ１２０）。すなわち、その画素についての本当の濃度とドットをオンまたはオフにしたことにより表現された濃度との誤差を計算し、これを着目している画素の周辺の画素に、所定の重みを付けて分配する処理を行なう。誤差拡散で印刷を行なう場合、処理済みの画素について生じた濃淡の誤差を予めその画素の周りの画素に所定の重みを付けて予め配分しておくので、該当する誤差分を読み出し、これを今から印刷しようとする画素に反映させるのである。着目している画素ＰＰに対して、周辺のどの画素にどの程度の重み付けで、この誤差を配分するかを、図１４に例示した。着目している画素ＰＰに対して、キャリッジ３０の走査方向で数画素、および用紙Ｐの搬送方向後ろ側の隣接する数画素に対して、濃度誤差が所定の重み（１／４，１／８、１／１６）を付けて配分される。

【００４７】なお、シアンインクＣとマゼンタインクについては、本実施例では、濃淡２種類のインクを用意しており、濃淡のドットを形成しているが、イエロインクＹの濃度を高くした点に特徴を有する本発明の理解の便

を図って、図１２に基づく以下の説明では、シアンおよびマゼンタについては、通常の濃度のインク（濃インクＣ１，Ｍ１に相当）だけでドット形成を行なうものとした。

【００４８】シアンインクについての以上の処理の後、次に同様の処理をマゼンタインクおよびイエロインクについて繰り返す。即ち、マゼンタについての階調データを入力し（ステップＳ１３０）、テーブルＴＭを参照してマゼンタのドットのオン・オフを決定し（ステップＳ１４０）、マゼンタについての誤差計算および誤差拡散の処理を行なう（ステップＳ１５０）。また、イエロについての階調データを入力し（ステップＳ１６０）、テーブルＴＹを参照してイエロのドットのオン・オフを決定し（ステップＳ１７０）、イエロについての誤差計算および誤差拡散の処理を行なう（ステップＳ１８０）。この際、シアン，マゼンタについての記録率と比べ、イエロインクによるドット形成の記録率は、図１３に示したテーブルの相違により、約２／３に低減される。

【００４９】イエロについてのドットの記録率が、マゼンタなどのインクのドットの記録率に対して２／３程度に押さえられている結果、イエロのドットは、階調データが最大の場合でも印刷領域を完全に埋め尽くしてしまうことがない。図１５は、マゼンタとイエロの階調が最大（階調データで２５５）の場合のドット形成の様子を示す説明図である。この例では、分散型ディザ法により３×３のマトリックスを単位として、ドットのオン・オフを決定している。図１５（ａ）は、通常濃度のイエロインクＹ１を用いた場合、階調データが最大の場合には、記録率が１００［％］になっていることを示す。これに対して、本実施例で用いた高濃度のイエロインクＹ２によりドットを形成する場合には、図１５（ｂ）に示すように、階調データが最大（２５５）の場合でも、イエロインクＹ２のドットは、６個しか形成されない。これに対してマゼンタインクＭのドットは、図１５（ｃ）に示したように、３×３の９個形成されることになる。この結果、両方のインクのドットが形成されると、図１５（ｄ）に示すように、３個のドットについては、マゼンタインクＭのみが用紙に吐出されることになる。

【００５０】上述した結果は、イエロインクの染料濃度を通常のイエロインクに対して１．５倍としたことにより生じたものである。イエロインクにより形成されたドットは、表現可能な階調数は通常の２／３となっているが、元々イエロインクは明度が高いため、原画像の低濃度の領域に対応してまばらにドットが形成されても粒状化はほとんど感じられない。この結果、粒状化による画質の低下という問題を引き起こすことなく、単位面積当たりに形成されるドットの総数、即ち単位面積当たりに吐出されるインク量を低減することができるという利点が得られる。単位面積当たりに吐出可能なインクの総量には、用紙毎に上限（デューティ制限）が存在するため、イエロインクの濃度を高くすることにより、必要なインク量が低減できるメリットは大きい。例えば、コンポジットブラックを、シアンインク１００［％］＋マゼンタインク１００［％］＋イエロインク６０［％］で実現できるのであれば、通常の濃度のイエロインク（最大記録率１００［％］）を用いた場合のデューティ（３００［％］）と比べて、用紙のデューティ制限に対して約４０［％］の余裕が生まれることになる。また、デューティ制限が１９０［％］の用紙上にダークレッドを出力する例では、従来はシアン１０［％］、マゼンタ１００［％］、イエロ１００［％］で印刷すると、その合計は２１０［％］となってデューティ制限を越えてしまうため、１０パーセント分をブラックインクに置き換え、マゼンタ９０［％］、イエロ９０［％］、ブラック１０［％］で印刷する必要があった。しかし、このようなブラックインクに置き換えて印刷すると、レッド中に最も高濃度で目立ちやすいブラックのドットがまばらに形成され、粒状性が悪化し、画質が低下していた。本実施例では、ブラックインクを用いなくても、シアン１０［％］、マゼンタ１００［％］、イエロ６７［％］でデューティ制限内に納め、粒状性が良く、高画質な出力を得ることができる。即ち、本実施例のようにイエロ濃度を上げれば、それによって得られるデューティ制限の余裕を利用して、各色インク量を最適化し、更なる高画質化を図ることが可能となる。

【００５１】さらに、本実施例では、イエロインクの染料濃度を高め、必要なドット数を低減していることから、各色インクの重ね打ちに対して、低減されたドット数だけ余裕が生じるという利点も得られる。インクの重なりについては、様々な工夫がなされているが、イエロインクについてドット形成されない箇所が１／３程度存在することは、こうした複数色の重ね打ちにおけるドット配置の自由度を高めることができるというメリットとなる。また、イエロインクによるドットの形成数が少ないと言うことは、所定の面積を印字する際のイエロインクの平均的な消費量も少ないと言うことである。この結果、インクカートリッジ７０に搭載すべきイエロインクの量も低減することができる。インク量を低減すれば、カートリッジ７０の重みが低減でき、カートリッジ７０を搬送する機構も簡略化することができる。また、イエロインクの容量を低減した分、他のインク量を増やすこともできる。本実施例のように、濃淡２種類のインクを用いる場合には、濃淡インクの量を増やすことができるので、そのメリットは大きい。

【００５２】以上、本発明の実施例について説明したが、このプリンタ２０では、濃淡２種類のインクを用いているので、マゼンタとシアンについての濃淡２種類のインクの使い分けについて簡単に説明する。テーブルＴＣを参照してシアンＣインクのドットのオンオフについて決定する処理（ステップＳ１１０）および同様にマゼ

ンタについて決定する処理（ステップＳ１４０）は、詳しくは濃淡２種類のインクについてドットを形成するか否かの判断を行なっている。

【００５３】両ステップでは、まず入力した階調データＤＳに基づき、濃ドットのオン・オフを決定する処理を行なう。この濃ドットのオン・オフを決定する処理の詳細を、図１７の濃ドット形成判断処理ルーチンに示した。この処理ルーチンでは、まず、階調データＤＳに基づいて図１８のテーブルを参照して、濃レベルデータＤｔｈを生成する処理を行なう（ステップＳ２２２）。図１８は、元の画像の階調データに対して、淡インクと濃インクの記録率をどの程度にするかを設定するテーブルを示す。階調データは、各色について０～２５５までの値をとるものしているから（各色８ビット）、以下階調データの大きさを１６／２５６等のように表現する。図１８のテーブルは、最終的に得られる印刷物における濃インクと淡インクの割合を示すものであり、ある階調データが与えられたとき、一意に濃インクの記録率と淡インクの記録率を与えて、着目している画素の濃インクまたは淡インクによるドットのオン・オフを定めるものではない。この関係を簡単に説明すると、本実施例では、まずこのテーブルを利用して濃ドットのオン・オフを判定し、その結果を参照して淡ドットのオン・オフを判定する。従って、淡ドットの記録率が図１８に示したテーブルに一致するのは、次の理由による。

【００５４】単位面積当たりの画像の濃度は、そこに形成される濃ドットと淡ドットの数により表すことができる。図１８に従って、単位面積当たりに形成された濃ドットの数を、濃度が最大の場合を値２５５としてこれに対する割合として考え、これをＫｓとする。同様に淡ドットの数をＵｓとする。このとき、形成される画像の濃度を入力した画像の階調データＤＳに等しくしようとすれば、

ＤＳ＝Ｋｓ×（濃ドットの評価値）／２５５＋Ｕｓ×（淡ドットの評価値）／２５５

となる。濃ドットの評価値（形成されたドットの濃さ）は２５５と見なすことができるので、濃ドットのテーブルと淡ドットの評価値をいくつにとるかにより、図１８に示した淡ドットのテーブルが決まることになる。図１８に示した例では、たとえば淡ドットの記録率が最大となる点（階調データが９５、濃ドットデータが１８、淡ドットデータが１２２）のデータを上式に入力すると、淡ドット評価値をＺとして

９５＝１８×２５５／２５５＋１２２×Ｚ／２５５

となり、淡ドット評価値は、１６０となる。なお、この濃ドット評価値、淡ドット評価値は、後述する濃ドット、淡ドットのオン・オフの決定手法のフローチャートで結果値ＲＶとして扱われているものと同じものである。

【００５５】入力した階調データＤＳに基づいて、図１８のテーブルを参照することにより、予め定めた濃インクの記録率に対応した濃レベルデータＤｔｈを得る（図１８右側縦軸）。例えば、入力したシアンの階調データが５０／２５６のベタの領域を印刷する場合には、濃インクであるシアンインクＣ１の記録率は０パーセントであり、濃レベルデータも値０となる。階調データが９５／２５６のベタの領域を印刷する場合には、濃インクであるシアンインクＣ１の記録率は７パーセントであり、濃レベルデータＤｔｈは値１８となる。更に、階調データが１９１／２５６のベタ領域を印刷する場合にはシアンインクＣ１の記録率は７５パーセントであって、濃レベルデータは値１９１となる。これらの場合に、後述する手法で淡ドットのオン・オフを判断すると、それぞれ、淡インクであるライトシアンインクＣ２の記録率は３６パーセント、５８パーセント、０パーセントとなる。

【００５６】次に、こうして得られた濃レベルデータＤｔｈが閾値Ｄref1より大きいか否かの判断を行なう（ステップＳ２２４）。この閾値Ｄref1は、着目した画素に濃インクによるドットを形成するか否かの判定値であって、単純に濃レベルデータＤｔｈの最大値の１／２程度に固定することもできる。本実施例では、この閾値の設定に分散型ディザの閾値マトリックスを採用し、特に６４×６４程度の大域的マトリックス（ブルーノイズマトリックス）を利用し、組織的ディザ法を適用し、閾値として分散型のマトリックスを採用した。従って、濃ドットのオンオフを定める閾値Ｄref1は、着目する画素毎に異なった値となる。分散型の閾値マトリックスとは、その閾値マトリックスにより決定されるドットの空間周波数が高いものであり、ドットが領域内でバラバラに発生するタイプを言う。具体的には、Ｂｅｙｅｒ型の閾値マトリックスなどが知られている。分散型のディザを採用すると、濃ドットの発生がバラバラに行なわれるので、濃淡ドットの分布が偏らず、画質が向上する。

【００５７】濃ドットデータＤｔｈが閾値Ｄref1より大きい場合には、その画素の濃ドットをオンにするものと判断し、更に結果値ＲＶを演算する処理を行なう（ステップＳ２２６）。結果値ＲＶは、その画素の濃度に相当する値（濃ドット評価値）であり、濃ドットがオン、即ちその画素に濃度の高いインクによるドットを形成すると判断した場合には、その画素の濃度の対応した値（例えば値２５５）が設定される。この結果値ＲＶは、固定値でも良いが、濃レベルデータＤｔｈの関数として設定しても良い。

【００５８】他方、濃レベルデータＤｔｈが閾値Ｄref1以下の場合には、濃ドットをオフ、即ち形成しないと判断し、更に結果値ＲＶに値０を代入する処理を行なう（ステップＳ２２８）。濃度の高いインクによるドットが形成されない箇所は、用紙の白地が残ることから、結果値ＲＶを値０とするのである。

【００５９】こうして濃ドットのオン・オフを決定し、結果値ＲＶを演算する処理を行なった後、次に図１７に示すように、まず、着目している画素の階調データＤＳに近傍の処理済みの画素からの拡散誤差△Ｄｕを加えた補正データＤＣを求める処理を行なう（ステップＳ２４０）。これは、誤差拡散の処理を行なうためである。その後、濃ドットをオン（シアンインクＣ１によるドット形成）としたか否かを判断し（ステップＳ２４２）、濃ドットを形成していない場合には、濃度の低いドット、即ちライトシアンインクＣ２によるドット（以下、淡ドットと呼ぶ）のオン・オフを決定する処理を行なう（ステップＳ２４４以下の処理）。

【００６０】ライトシアンインクＣ２によるドットの形成は、実施例では、この誤差拡散法を適用し、誤差拡散の考え方で補正した階調データＤＣが淡ドット用の閾値Dref2より大きいか否かの判断を行なう（ステップＳ２４４）。この閾値Dref2は、着目した画素に濃度の低い淡インクによるドットを形成するか否かの判定値であって、本実施例では、補正済みのデータＤＣに応じて可変される値として設定した。

【００６１】補正データＤＣが閾値Dref2より大きければ淡ドットをオンすると判断し、結果値ＲＶ（淡ドット評価値）を演算する（ステップＳ２４６）。結果値ＲＶは、本実施例では、値１２２を基準値とし、補正データＤＣにより補正される値とした。他方、補正データＤＣが閾値Dref2以下と判断された場合には、淡ドットをオフにすると判断し、結果値ＲＶに値０を算入する処理を行なう（ステップＳ２４８）。

【００６２】こうして淡ドットと濃ドットによる記録が行なわれることになるが、この様子をシアンインクＣ１とライトシアンインクＣ２とについて模式的に示したのが、図１９である。入力された階調データが低い領域（実施例では、階調データが０／２５６～６３／２５６の領域）では、図１９（ａ），（ｂ）に示すように、ライトシアンインクＣ２によるドットだけが形成され、かつ階調データが高くなるにつれて、所定の領域内に存在する淡ドットの割合は増加し（図１９（ｃ）ないし（ｅ））、階調データが更に高くなると、淡ドットの形成は行なわれなくなり濃ドットだけが形成される（図１９（ｆ），（ｇ））。階調データが最大となれば、図１９（ｈ）に示すように、濃ドットによる記録率が１００パーセントとなる。

【００６３】以上説明した本実施例のプリンタ２０では、通常より染料濃度の高いイエロインクを採用する一方で、濃淡２種類のシアンインクおよびマゼンタインクを有するインクカートリッジ７０をキャリッジ３０に搭載し、入力画像の階調が低い領域では、染料濃度の低いライトシアンインクおよびライトマゼンタインクを用いて印字を行なうので、階調が低い領域での粒状感が目立たず、印字品質が極めて高いという利点が得られる。イエロインクの濃度は、イエロインクのドットについての粒状感が目立たない範囲で高くすることができるから、染料濃度で４倍程度までは可能である。このとき、イエロインクの平均的な吐出量を、大幅に低減することができる。

【００６４】上記実施例では、イエロインクの濃度を高くしたが、イエロインクに限定されるものではなく、印刷に利用されるインクの色の組み合わせの中で、最も明度の高いインクあるいは最も粒状化の視認性が低いインクの濃度を高めればよい。また、本実施例では、イエロインクの染料濃度を高めたことによる色バランスの偏りの是正は、イエロインクのドット形成の割合を低くすることにより行なったが、イエロインクにより形成されるドットの径を低減することによっても、この偏りを是正することができる。用紙Ｐ上に形成されるドットの大きさは、インク吐出用のノズルの直径やピエゾ素子ＰＥに印可する電圧パルスの強さ（電圧及び継続時間）等を調整することにより制御することができる。例えば、上記実施例のイエロインク用のノズル６６を小径ドット用のノズルとして形成し、シアンインクＣ用のノズル６２，６３とマゼンタインクＭ用のノズル６４，ロゴを大径ドット用のノズルとして形成すればよい。

【００６５】上記本実施例では、各色ドットの形成を制御するプログラムは、プリンタ２０側ではなくコンピュータ９０のプリンタドライバ９６側に用意したが、プリンタ２０内に用意することも可能である。例えば、コンピュータ９０からは、ポストスクリプトなどの言語により印刷する画像情報が送られてくる場合には、プリンタ２０側にハーフトーンモジュール９９などを持つことになる。また、これらの機能を実現するソフトウェアプログラムは、本実施例では、コンピュータ９０内のハードディスク等に記憶されており、コンピュータ９０が起動する際にプリンタドライバの形態でオペレーティングシステムに組み込まれるが、フロッピディスクやＣＤ－ＲＯＭ等の携帯型記憶媒体（可搬型記憶媒体）に格納され、携帯型記憶媒体からコンピュータシステムのメインメモリまたは外部記憶装置に転送されるものとすることも可能である。また、コンピュータ９０からプリンタ２０の内部に転送して利用する形態とすることも可能である。なお、通信回線を介して、これのソフトウェアプログラムを提供する装置を設け、上記ハーフトーンモジュールの処理内容を、通信回線を介して、このコンピュータやプリンタ２０に転送して利用する形態とすることもできる。

【００６６】また、上述した実施例では、濃淡いずれのインクの吐出も、ピエゾ素子ＰＥを用い、ピエゾ素子ＰＥに所定時間幅の電圧を印可することにより行なっているが、この他のインク吐出方式を採用することも容易である。実用化されているインク吐出方式としては、大まかに分けると、連続したインク噴流からインク粒子を分

離して吐出する方式と、上述した実施例でも採用された方式であるオンデマンド方式に大別される。前者には、荷電変調によりインクの噴流から液滴を分裂させる荷電変調方式、インクの噴流から大径粒子が分裂する際に生じる微少なサテライト粒子を印字に利用するマイクロドット方式などが知られている。これらの方式も、複数種類の濃度のインクを利用した本発明の印刷装置に適用可能である。

【００６７】また、オンデマンド方式は、ドット単位でインク粒子が必要となったとき、インク粒子を生成するものであり、上述した実施例で採用したピエゾ素子を用いた方式の他、図２０（Ａ）～（Ｅ）に示すように、インクのノズルＮＺ近傍に発熱体ＨＴを設け、インクを加熱することでバブルＢＵを発生させ、その圧力によりインク粒子ＩＱを吐出する方式などが知られている。これらのオンデマンド方式のインク吐出方式も、複数種類の濃度のインクあるいは径の異なる複数のドットを利用する本発明の印刷装置に適用可能である。なお、明度の最も高いインクまたは粒状化の視認性が最も低いインクの濃度を高くすると言う考え方は、このほか、熱転写方式のカラープリンタやレーザなどの電子写真方式のカラープリンタにも適用することができる。

【図面の簡単な説明】

【図１】実施例のプリンタ２０の概略構成図である。

【図２】プリンタ２０における制御回路４０の構成を示すブロック図である。

【図３】キャリッジ３０の構成を示す斜視図である。

【図４】印字ヘッド２８における各色ヘッド６１ないし６６の配置を示す説明図である。

【図５】カラーインク用カートリッジ７０の形状を示す斜視図である。

【図６】各色ヘッド６１ないし６６におけるインク吐出のための構成を示す説明図である。

【図７】ピエゾ素子ＰＥの伸張によりインク粒子Ｉｐが吐出される様子を示す説明図である。

【図８】コンピュータ９０が扱う画像情報から印刷が行なわれるまでの処理の様子を例示するブロック図である。

【図９】各色インクの成分を示す説明図である。

【図１０】各色インクの記録率と明度との関係を例示するグラフである。

【図１１】ＣＩＥＬＡＢ空間での各色インクの色相と彩度の関係を示す説明図である。

【図１２】ハーフトーンモジュール９９における処理を例示するフローチャートである。

【図１３】シアン，マゼンタ，イエロインクにおける入力データと記録率との関係を示すテーブルを示す説明図である。

【図１４】誤差拡散における周辺ドットへの誤差の配分の様子を例示する説明図である。

【図１５】イエロとマゼンタインクによるドットの形成の様子を示す説明図である。

【図１６】濃ドット形成判断処理ルーチンを示すフローチャートである。

【図１７】淡ドット形成判断処理ルーチンを示すフローチャートである。

【図１８】本実施例における淡インクと濃インクとによる記録率と階調データとの関係を例示するグラフである。

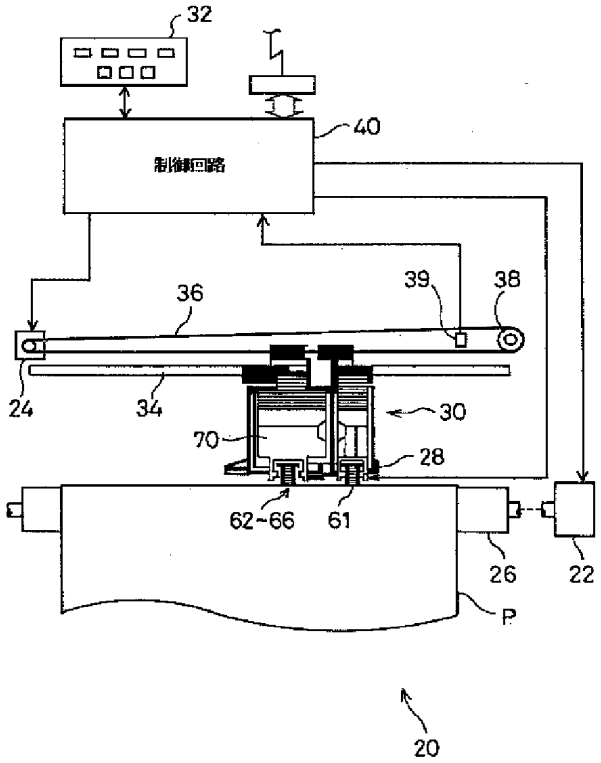
【図１９】濃淡インクによるドット形成の過程を例示した説明図である。

【図２０】インク粒子の吐出機構の他の構成例を示す説明図である。

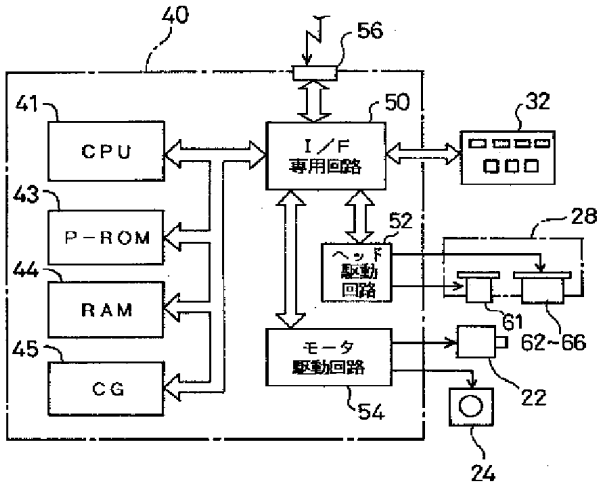
【符号の説明】

２０…プリンタ
２２…紙送りモータ
２４…キャリッジモータ
２６…プラテン
２８…印字ヘッド
３０…キャリッジ
３１…仕切板
３２…操作パネル
３４…摺動軸
３６…駆動ベルト
３８…プーリ
３９…位置検出センサ
４０…制御回路
４１…ＣＰＵ
４３…ＲＯＭ
４４…ＲＡＭ
５０…Ｉ／Ｆ専用回路
５２…ヘッド駆動回路
５４…モータ駆動回路
５６…コネクタ
６１～６６…インク吐出用ヘッド
７０…カラーインク用カートリッジ
７１…導入管
８０…インク通路
９０…コンピュータ
９１…ビデオドライバ
９３…ＣＲＴディスプレイ
９５…アプリケーションプログラム
９６…プリンタドライバ
９７…ラスタライザ
９８…色補正モジュール
９９…ハーフトーンモジュール
Ｐ…用紙
ＰＥ…ピエゾ素子
ｎ…ノズル

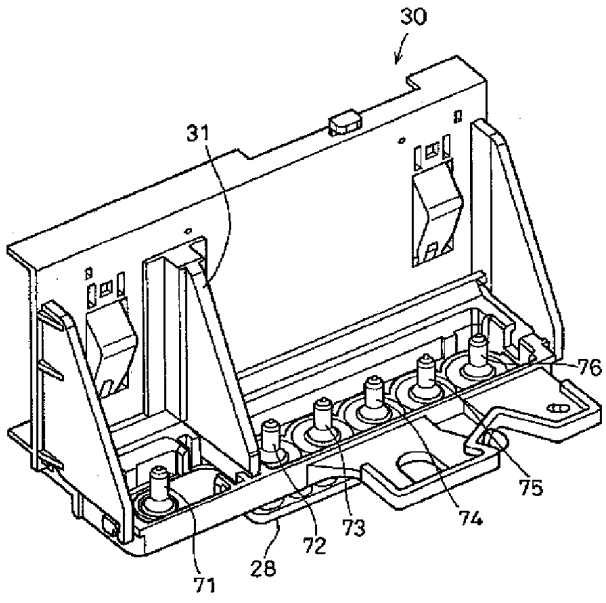
【図１】



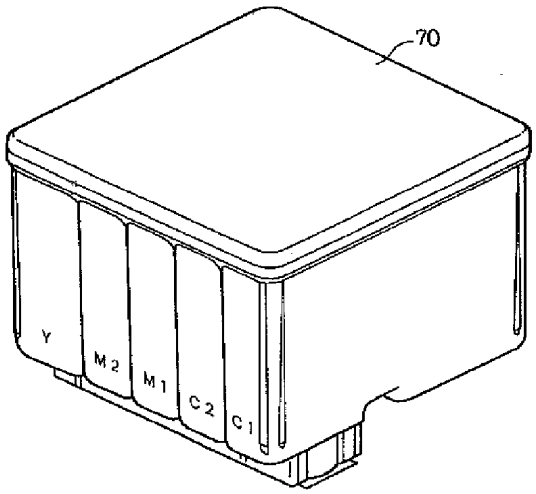
【図２】



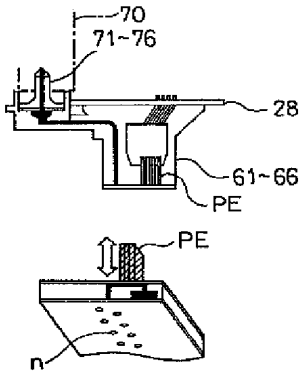
【図３】



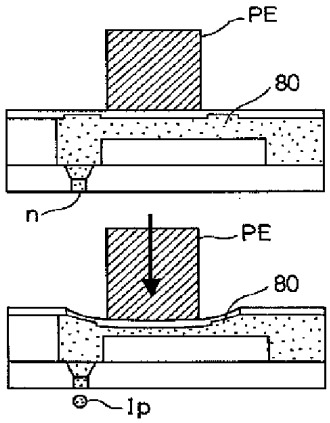
【図５】



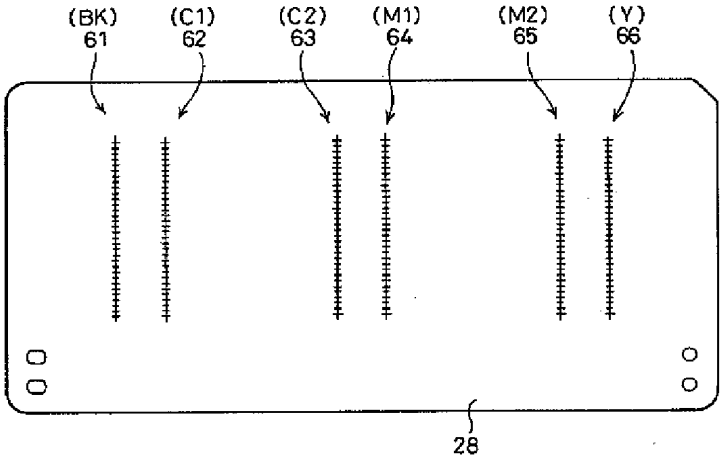
【図６】



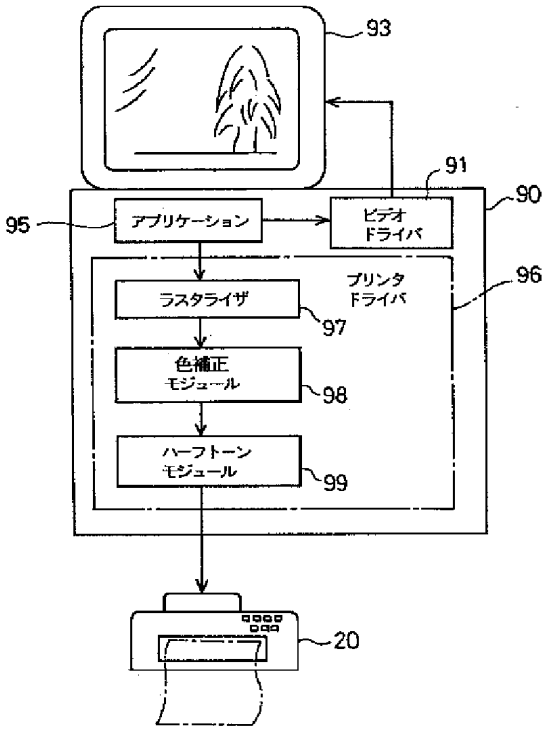
【図７】



【図４】



【図８】

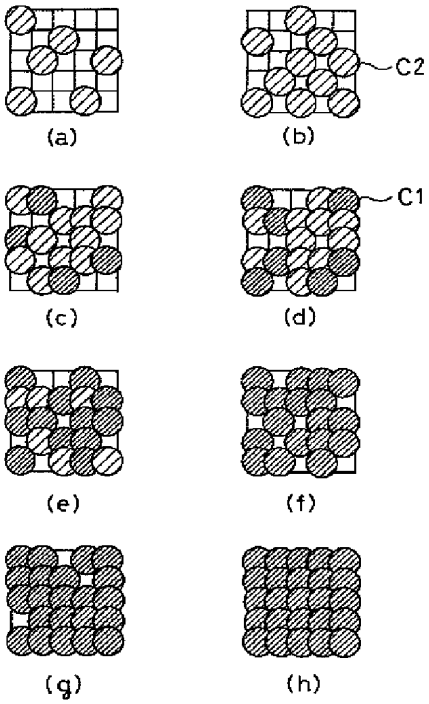


【図９】

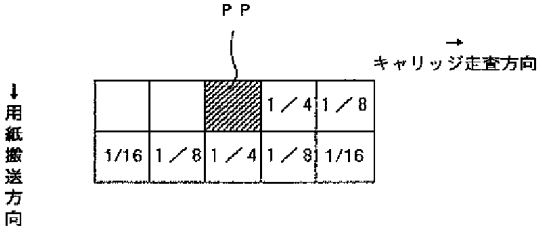
インク組成　及び　特性

		C1	C2	M1	M2	Y	Bk
染料	Directblue199	3.6	0.9				
	Acidred289			2.8	0.7		
	Directyellow86					2.7	
	Foodblack2						4.8
ジエチレングリコール		30	35	20	25	30	25
サーフィノール４６５		1	1	1	1	1	1
水		65.4	63.1	79	74	69	74
粘度（mPa・s）		3.0	3.0	3.0	3.0	3.0	3.0

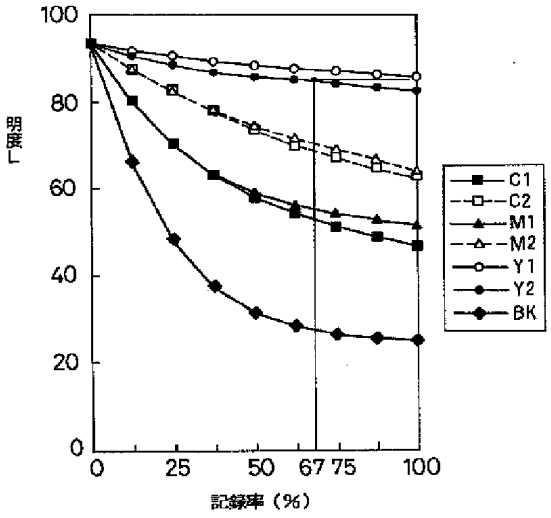
【図１９】



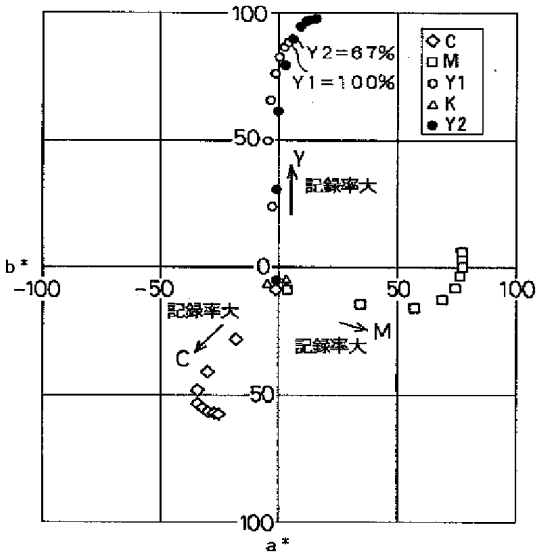
【図１４】



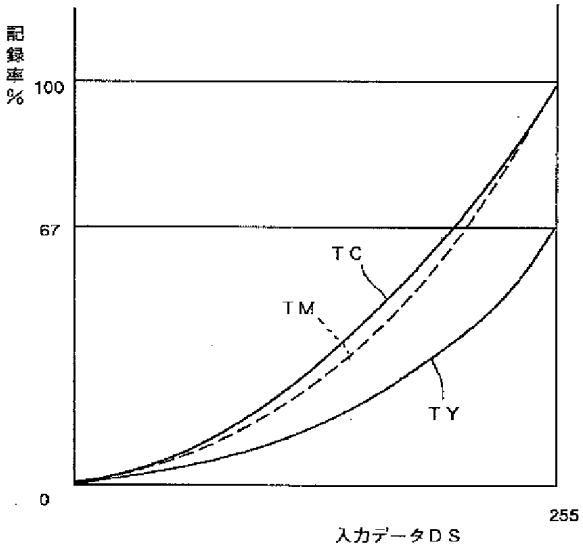
【図１０】



【図１１】

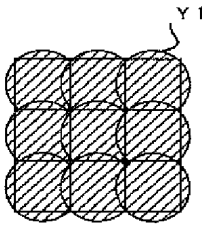


【図１３】

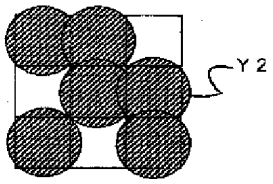


【図１５】

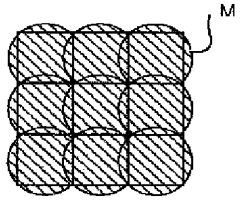
（ａ）通常濃度のイエロインクによる記録率100%



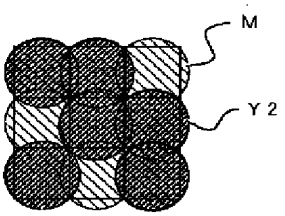
（ｂ）濃度の高いイエロインクによる記録率67%（形成された画像の濃度は（ａ）に同じ）



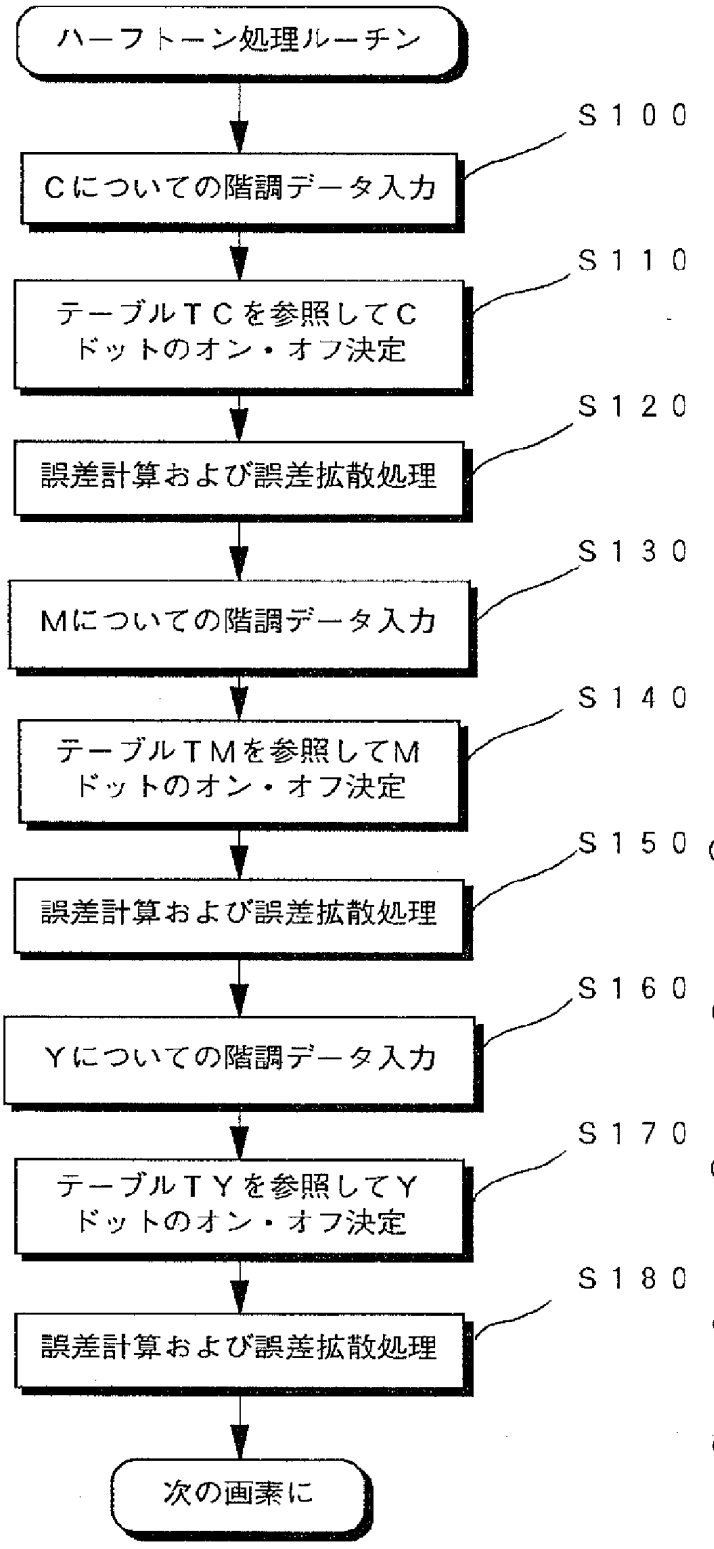
（ｃ）通常濃度のマゼンタインクMによる記録率100%



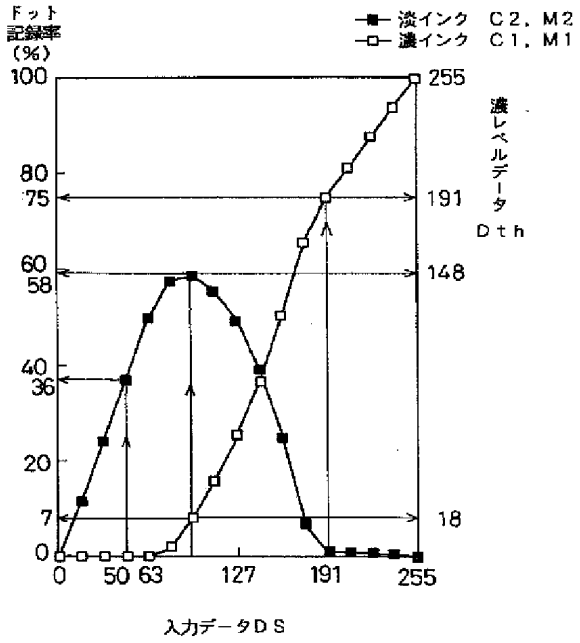
（ｄ）濃度の高いイエロインクによる記録率67%、及び通常濃度のマゼンタインクMによる記録率100%



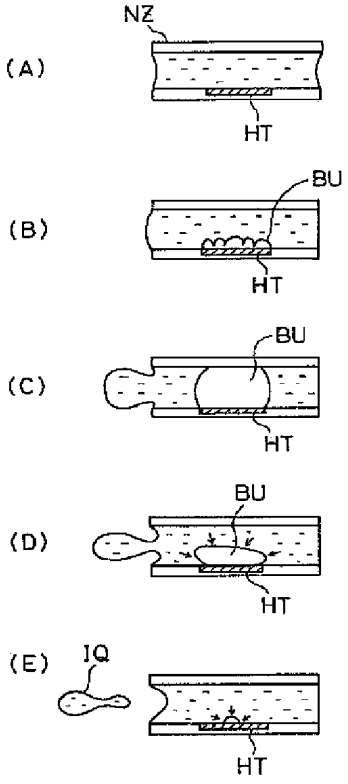
【図１２】


ハーフトーン処理ルーチン
S１００
Cについての階調データ入力
S１１０
テーブルＴＣを参照してC
ドットのオン・オフ決定
S１２０
誤差計算および誤差拡散処理
S１３０
Mについての階調データ入力
S１４０
テーブルＴＭを参照してM
ドットのオン・オフ決定
S１５０
誤差計算および誤差拡散処理
S１６０
Yについての階調データ入力
S１７０
テーブルＴＹを参照してY
ドットのオン・オフ決定
S１８０
誤差計算および誤差拡散処理
次の画素に

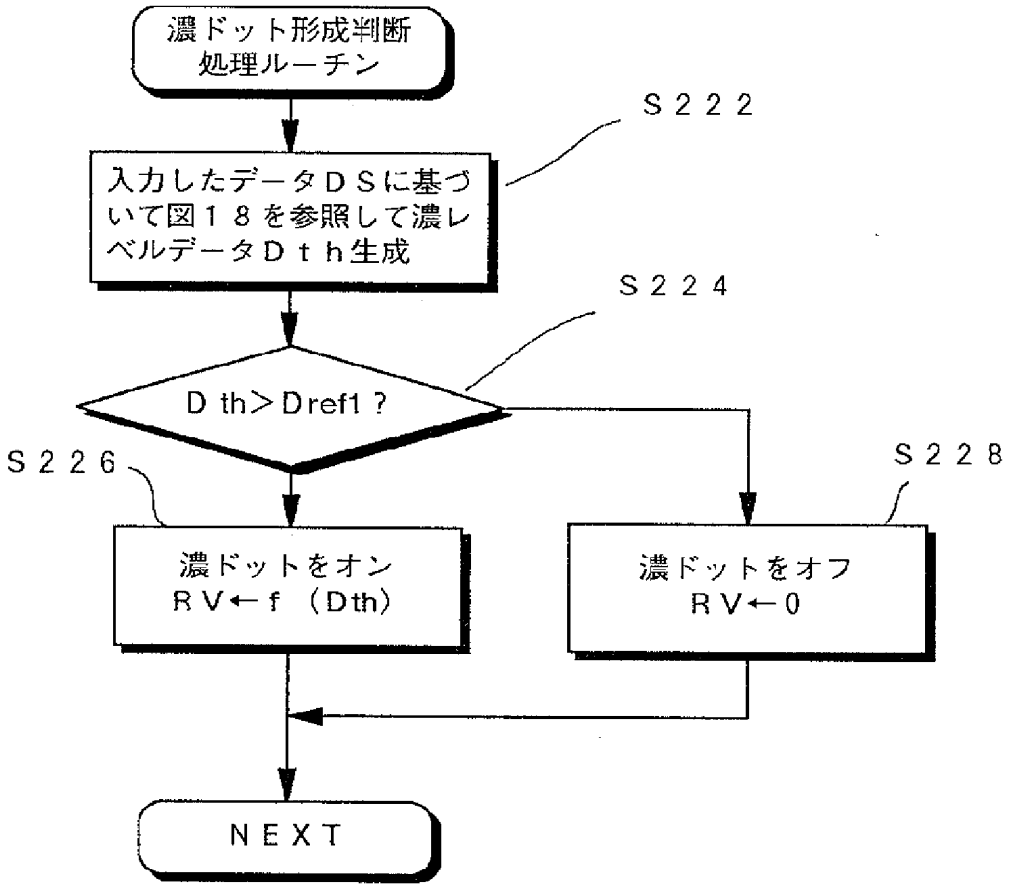
【図１８】


ドット記録率（%）
淡インク　C２，M２
濃インク　C１，M１
100
80
75
60
58
40
36
20
7
0
255
191
148
18
濃レベルデータ Dth
0
50
63
127
191
255
入力データDS

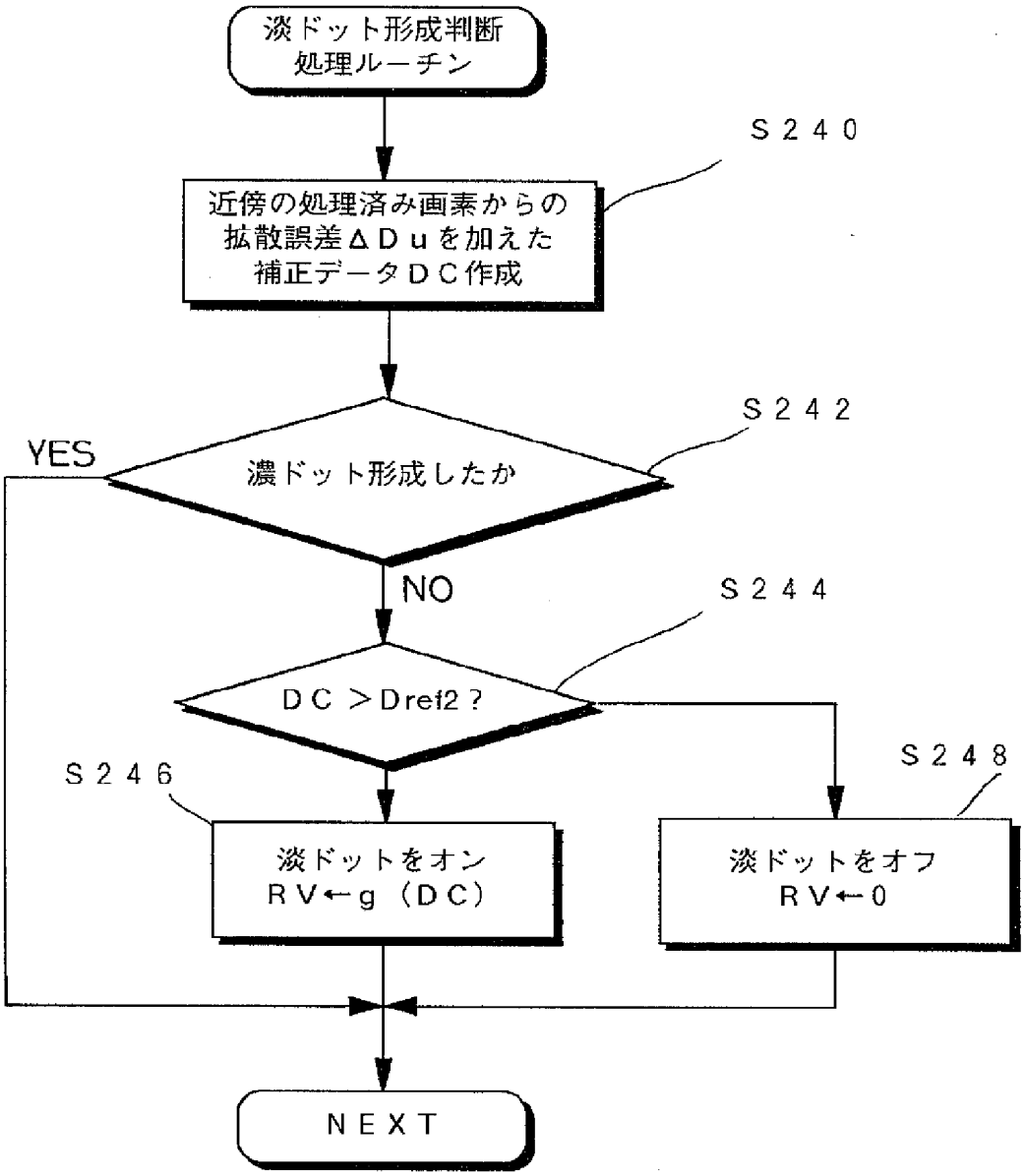
【図２０】


(A)
NZ
HT
(B)
BU
HT
(C)
BU
HT
(D)
BU
HT
(E)
IQ
HT

【図１６】


濃ドット形成判断
処理ルーチン
Ｓ２２２
入力したデータＤＳに基づいて図１８を参照して濃レベルデータＤｔｈ生成
Ｓ２２４
Ｄ th＞Dref1？
Ｓ２２６
Ｓ２２８
濃ドットをオン
ＲＶ←ｆ（Dth）
濃ドットをオフ
ＲＶ←0
ＮＥＸＴ

【図１７】


淡ドット形成判断
処理ルーチン
Ｓ２４０
近傍の処理済み画素からの
拡散誤差ΔＤｕを加えた
補正データＤＣ作成
Ｓ２４２
YES
濃ドット形成したか
NO
Ｓ２４４
ＤＣ ＞Dref2？
Ｓ２４６
淡ドットをオン
ＲＶ←ｇ（ＤＣ）
Ｓ２４８
淡ドットをオフ
ＲＶ←０
ＮＥＸＴ